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NATIONAL DAM SAFETY PROGRAM. PERTLE SPRINGS LAKE DAM (MO 20044)--ETC(U)
MAY 80 P R ZAMAN, E R BURTON, H L CALLAHAN DACW43-80-C-0074

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MISSOURI-KANSAS CITY BASIN

PERTLE SPRINGS LAKE DAM

JOHNSON COUNTY, MISSOURI

MO 20044

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PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

United States Army Corps of Engineers
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A106 169	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Pertle Springs Dam (MO 20044) Johnson County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Black & Veatch, Consulting Engineers		8. CONTRACT OR GRANT NUMBER(s) DACW43-80-C-0074
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE May 1980
		13. NUMBER OF PAGES Approximately 65
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

National Dam Safety Program. Pertle Springs Lake Dam (MO 20044), Missouri - Kansas City Basin, Johnson County, Missouri. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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PERTLE SPRINGS LAKE DAM

JOHNSON COUNTY, MISSOURI

MO 20044

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

MAY 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

LMSED-PD

SUBJECT: Pertle Springs Lake Dam, MO. I.D. No. 20044
Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Pertle Springs Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — 25 SEP 1980
Chief, Engineering Division — Date

APPROVED BY : SIGNED — 25 SEP 1980
Colonel, CE, District Engineer — Date

PERTLE SPRINGS LAKE DAM

JOHNSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20044

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

MAY 1980

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Pertle Springs Lake Dam
State Located	Missouri
County Located	Johnson County
Stream	Tributary to East Fork Post Oak Creek
Date of Inspection	15 May 1980

Pertle Springs Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately two miles downstream of the dam. Within the estimated damage zone are one trailer court, one 1-acre lake, and one 20-acre lake. Contents of the estimated damage zone were verified by the inspection team.

The inspection and evaluation indicates that the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillways will pass neither 50 nor 100 percent of the probable maximum flood without overtopping but will pass 25 percent of the probable maximum flood. The spillways will pass the flood which has a 1 percent chance of occurrence in any given year. The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the volume of water impounded behind the dam, and the contents of the estimated damage zone, the spillway design flood should be 100 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in satisfactory condition. Deficiencies visually observed by the inspection team were, seepage downstream of the dam on the right abutment, seepage from under the emergency spillway concrete inlet structure, erosion of embankment material on the upstream slope beneath the riprap, and numerous animal burrows on the embankment. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

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Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
PERTLE SPRINGS LAKE DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Pertle Springs Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary to East Fork Post Oak Creek (Plate 1). The watershed is an area of low hills consisting of approximately 70 percent forested area, 5 percent residential area, 10 percent grassland and 15 percent crop land (Plate 2). The dam is approximately 560 feet long along the crest and 20 feet high. The dam crest is 10 feet wide. The downstream face of the dam slopes gradually from the crest to the valley floor below.

(2) The primary spillway from the lake is an uncontrolled 60-inch Drop Inlet constructed of steel pipe connected to a 36-inch horizontal steel outlet pipe installed in the embankment. Flow through the pipe discharges into a rock and concrete channel below. The emergency spillway consists of a rectangular concrete notch overflow structure with a concrete sill which discharges to a concrete apron, then to a channel excavated from the embankment material and natural overburden. Discharge through the emergency spillway overflows through the valley downstream to a small lake.

(3) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in central Johnson County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Centerview, Missouri in Section 35 of T46N, R26W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the small size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Pertle Springs Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Pertle Springs Lake Dam the estimated flood damage zone extends approximately two miles downstream of the dam. Within the estimated damage zone are one trailer court, one 1-acre lake and one 20-acre lake. Contents of the estimated damage zone were verified by the inspection team.

e. Ownership. The dam is owned by Central Missouri State College, Warrensburg, Missouri, 64093, Telephone 816-429-4111.

f. Purpose of Dam. The dam forms a 16-acre lake used for recreation which was originally used for water supply.

g. Design and Construction History. Data relating to the design and construction were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and overflow through the emergency spillway and uncontrolled outlet pipe all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 454 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled 60-inch drop inlet connected to a 36-inch outlet pipe.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 700 cfs (Probable Maximum Flood Pool El.779.1).

c. Elevation (Feet above m.s.l.).

(1) Top of dam - 777.6 (see Plate 3)

(2) Emergency spillway crest - 774.4

(3) Primary spillway crest - 774.0

(4) Streambed at toe of dam - 757.0 ±

(5) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 2,200 feet ± (Probable maximum flood pool level)

(2) Length of normal pool - 1,800 feet ± (Primary spillway crest)

e. Storage (Acre-feet).

(1) Top of dam - 149

(2) Emergency spillway crest - 82

(3) Primary spillway crest - 75

(4) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 25.8

(2) Emergency spillway crest - 17.2

(3) Primary spillway crest - 16.1

g. Dam.

(1) Type - Earth embankment

(2) Length - 560 feet

(3) Height - 20 feet ±

(4) Top width - 10 feet

(5) Side slopes - upstream face 1.0 V on 2.6 H, downstream face between 1.0 V on 2.8 H and 1.0 V on 5.0 H (see Plate 4)

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Primary Spillway.

(1) Type - 60-inch drop inlet steel pipe connected to 36-inch steel outlet pipe.

(2) Inlet crest - 774.0 feet m.s.l.

(3) Outlet invert elevation 754.7 feet m.s.l.

(4) Gates - None.

(5) Upstream channel - Not applicable.

(6) Downstream channel - Rock and concrete channel

j. Emergency Spillway.

(1) Type - Rectangular concrete notch.

(2) Width of channel - 16 feet.

(3) Emergency spillway crest - 774.4.

(4) Gates - None.

(5) Upstream channel - Not applicable.

(6) Downstream channel - Concrete apron then into a downstream soil and rock channel.

k. Regulating Outlets - None. Drain valve located in primary spillway drop inlet pipe. Size and elevation unknown.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data was unavailable.

2.2 CONSTRUCTION

Construction records were unavailable.

2.3 OPERATION

Procedural criteria for operation of this dam were not available. Documentation of past experiences of a serious nature was also not available.

2.4 GEOLOGY

The site of the dam and reservoir is located in a deeply dissected valley between two ridges. The dam impounds a small intermittent tributary of the East Fork of Post Oak Creek.

The soils of the dam and reservoir area consist of the Bolivar and Blackoar soil series. The Bolivar series consists of moderately deep, well-drained soils formed in residuum from sandstone on uplands. The depth to rock is 20-40 inches. For engineering purposes the soils are classified as low plastic silt (ML), silty sand (SM), clayey sand (SC) or low plastic clays (CL). The Blackoar series consists of deep, poorly-drained soils on nearly level areas in the floodplain. The depth to bedrock is greater than 60 inches. For engineering purposes the soil is classified as a low-plastic silt (ML) or a low plastic clay (CL).

The bedrock of the dam and reservoir area consists of sandstone of the Warrensburg member of the Pleasanton Group, Desmoinesion Series, Pennsylvanian System. The sandstone is a channel sandstone that is massive, medium grained, micaceous, and crossbedded.

2.5 EVALUATION

a. Availability. No engineering data could be obtained.

b. Adequacy. No engineering data was available upon which to make a detailed assessment of the design, construction, and operation. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability

analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Pertle Springs Lake Dam was made on 15 May 1980. The inspection team consisted of Edwin R. Burton, team leader; Robert Pinker, geologist; Gary Van Riessen, geotechnical engineer; John Ruhl, hydrologist/hydraulic engineer; and Russell Burnham, structural engineer. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. No cracks, sloughing or other signs of settlement were observed. No instruments to measure the performance of the dam were located.

Seepage was observed on the right abutment and downstream of the embankment but no visible flow was evident. Clear seepage (about 5 gpm) was observed coming from under the emergency spillway concrete inlet structure. No toe drains or relief wells were observed.

The dam crest has a gravel roadway surface which has been subjected to heavy foot traffic. The upstream slope of the embankment is faced with riprap. The downstream slope has a clover-type vegetative cover. Some erosion was evident on the upsteam slope as indicated by occasional holes and pockets in the riprap. Also, erosion of the sandy silt/sandy clay embankment material at the emergency spillway to near the crest of the dam may indicate that the dam has been overtopped. Backfill concrete had been placed around the emergency spillway structure to repair the embankment.

Evidence that a maintenance program was in effect included mowing of grass on the embankment, cutting of trees noted by a few stumps on the embankment and the clover-type vegetative cover planted on the downstream slope which appeared to be fairly new. It was perhaps the first or second year since planting as evidenced by the presence of straw mulch.

Many animal burrows were observed on the embankment. The area considered as the upstream channel to the lake contains several small dams and lakes located in an area of low hills. The lake water was noted to be clear containing a minor amount of siltation.

c. Appurtenant Structures. The inspection team observed the following items pertaining to the appurtenant structures. The primary spillway consists of an uncontrolled 60-inch drop inlet constructed of steel pipe connected to a 36-inch horizontal steel outlet pipe. The inlet has wire trash screens and a steel hatch cover. A valve stem was observed inside the drop inlet but could not be investigated further since the hatch cover was locked. The 36-inch outlet pipe was inspected from the downstream end and was found to be straight. About 4-feet of the drop inlet pipe interior was inspected and no corrosion was found. No evidence of leakage was noted into, out of or around the spillway pipe. The pipe joints themselves could not be observed and the majority of the spillway pipe was considered unobservable.

Some backfill concrete was recently placed on the upstream face of the dam around the drop inlet, probably to replace eroded embankment material. The primary spillway is considered to be in satisfactory condition.

The emergency spillway consists of a rectangular concrete notch inlet structure with a concrete control sill which discharges onto a backfill concrete apron then into a downstream soil and rock channel. This concrete was inspected and found to be in satisfactory condition. As previously noted there was clear seepage (5 gpm) coming from under the emergency spillway backfill concrete apron. Also some unmeasurable seepage was observed coming from under the concrete sill. It was noted that the control sill concrete had been repaired.

The emergency spillway contains no obstructions to flow and is considered to be in satisfactory condition. Backfill concrete has been placed around the emergency spillway which may indicate that erosion of the sandy silt/sandy clay embankment material may have occurred and that the dam has been overtopped. It should be noted that an abnormally large spillway discharge would probably overflow and erode the embankment.

There was no development in the emergency spillway area which could suffer damage due to flow through the spillway.

d. Geology. The soils in the area of the dam and reservoir are formed in alluvium and in residuum from sandstone. The alluvial soils are present in the downstream channel and consist of silts and sandy clays of low plasticity (ML or CL). The soils on the slopes around the reservoir are silty or clayey sands (SM or SC).

No outcrops of rocks were observed in the area of the dam and reservoir. However, the general depth to rock is anticipated to be 2-5 feet on the slopes and 10-20 feet in the downstream channel.

Samples of the embankment were taken near the center of the upstream crest using an Oakfield sampler. The materials were classified as one foot of sandy silt (ML) over sandy clay (CL) in accordance with ASTM D 2488-69. Based on these samples, it is anticipated that the embankment consists of sandy clay with a cover of approximately one foot of sandy silt.

The abutments and foundation of the dam are anticipated to consist of silty clay or silty sand overlying sandstone bedrock.

e. Reservoir Area. No slumping or slides of the reservoir banks were observed.

f. Downstream Channel. No obstructions, slumping, or slides were observed in the downstream channel.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control. The three seepage areas that were observed, on the right abutment, below the dam and under the emergency spillway concrete inlet structure, should be monitored regularly for quality and quantity. Seepage can lead to piping failure of the embankment and/or abutment material.

Burrowing animals will continue to damage the embankment if no program is undertaken to eliminate them. Piping failure of the embankment has resulted in similar small earth dams due to burrowing animal damage.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, and capacity of the emergency spillway and the uncontrolled primary spillway outlet pipe.

4.2 MAINTENANCE OF DAM

The existing maintenance program includes removal of brush and mowing the grass on the crest and slopes of the dam. Some recent concrete repair work was noted at the primary and emergency spillways.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

The maintenance program should continue to include mowing the grass cover on the embankment in order to discourage animal burrowing. A program should be undertaken to eliminate the burrowing animals. The areas of seepage should be monitored periodically and, if flows increase significantly or if seepage flows become muddy, a professional engineer experienced in the design, construction, and inspection of earth dams should be consulted.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data were unavailable.

b. Experience Data. The drainage area and lake surface area are developed from USGS Centerview Quadrangle Map. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The primary spillway appears to be in good condition. The lake level at the time of the inspection was below the inlet level and there was no flow through the pipe. Only the inlet and outlet ends were observable. The spillway pipe discharges to a channel constructed of rock and concrete. There were no obstructions to flow in the downstream channel.

(2) The emergency spillway channel is in good condition with no evidence of erosion at the time of the inspection. Seepage flow of approximately 5 gpm was observed flowing from beneath the discharge apron.

(3) Spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. The hydrologic and hydraulic analyses for the subject reservoir including routing through the upstream reservoir are outlined in Appendix A. The spillways will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillways will pass 25 percent of the probable maximum flood without overtopping the dam. The spillways will pass the one percent chance flood estimated to have a peak outflow of 530 cfs developed by a 48-hour, one percent chance rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the volume of water impounded by the dam, and the contents of the estimated damage zone, the appropriate spillway design flood should be 100 percent of the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 1,400 cfs of the total discharge from the reservoir of 2,000 cfs. The estimated duration of overtopping is

2.0 hours with a maximum height of 0.7 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 3,500 cfs of the total discharge from the reservoir of 4,200 cfs. The estimated duration of overtopping is 5.3 hours with a maximum height of 1.5 feet. The embankment could be in jeopardy should it be overtopped for this period of time.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately two miles downstream of the dam. One trailer court, one 1-acre lake, and one 20-acre lake could be severely damaged and lives could be lost should failure of the dam occur. Contents of the estimated damage zone were verified by the inspection team. There does not appear to be any floodplain regulations or other constraints in force to limit future downstream development.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records were available.

d. Postconstruction Changes. It appears that additional concrete work has been performed on the emergency spillway discharge apron since the spillway's original construction. The date and reason for the work are unknown.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry.

Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored and/or controlled. These are seepage from the right abutment, below the dam and under the emergency spillway concrete inlet structure, erosion of embankment material on the upstream slope beneath the riprap, and animal burrows in the embankment. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the lack of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional investigation noted in paragraph 2.5.b is necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment was not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. The emergency spillway size and/or height of the dam would need to be increased or the lake level would need to be lowered to increase storage in order to pass the spillway design flood. Any

work undertaken to remedy the hydraulic inadequacies should consider effects on the Lions Lake reservoir downstream of the subject embankment.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be carried out under the direction of an engineer experienced in the design, construction, and inspection of earth dams:

(1) The eroded areas beneath the riprap on the upstream face should be excavated, backfilled, and compacted with suitable material and the riprap should be repaired.

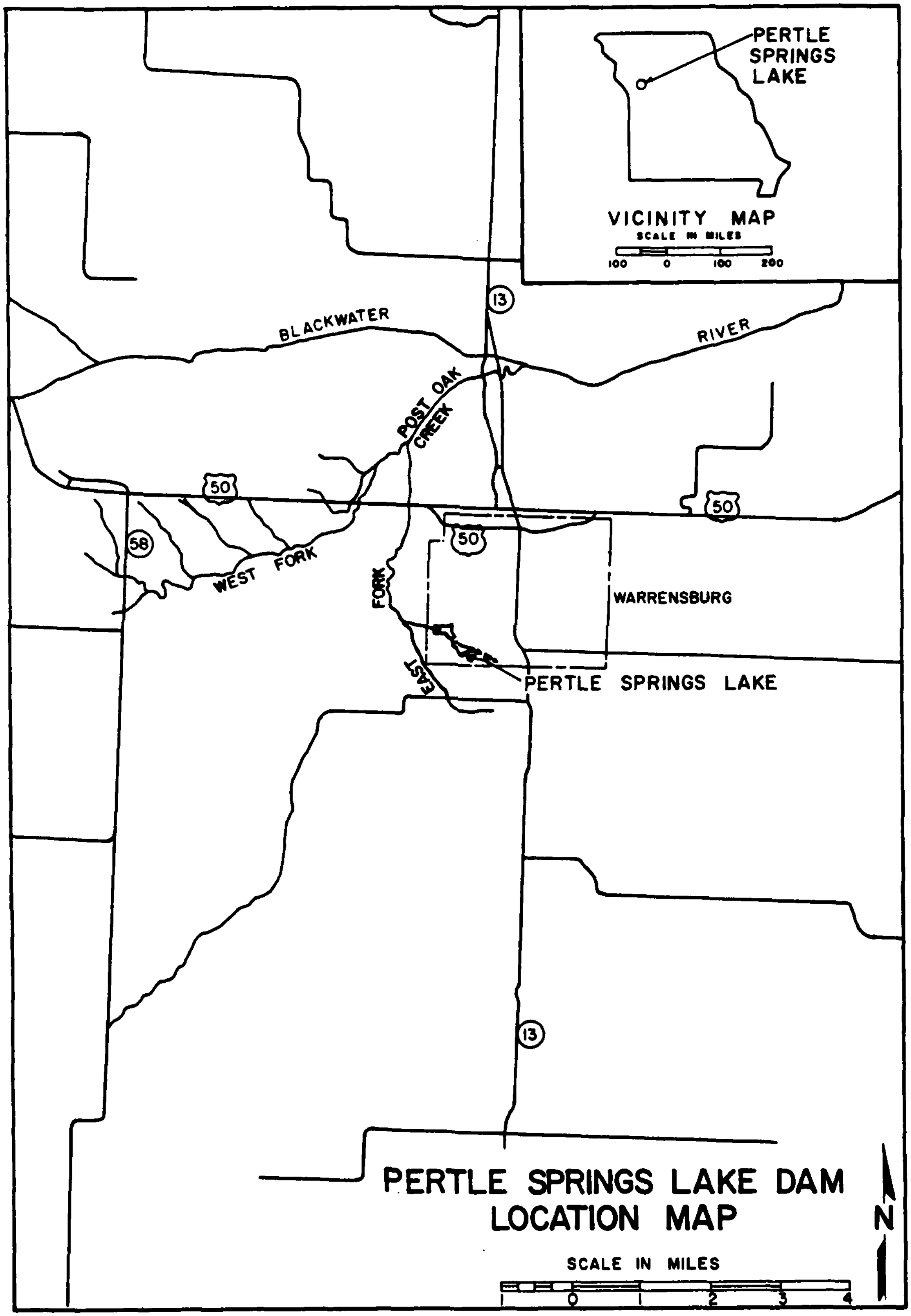
(2) The seepage areas noted during the visual inspection should be closely monitored and documented as to quantity of flow. Any significant changes should be evaluated.

(3) The animal burrows in the embankment should be repaired since they can lead to piping. Control measures should be implemented to discourage animal activity in the area.

(4) An improved maintenance program to remove and control the growth of brush and trees on the embankment should be developed. Grass cover on the embankments should be cut periodically.

(5) Seepage and stability analyses should be performed.

(6) A detailed inspection of the dam should be made periodically. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.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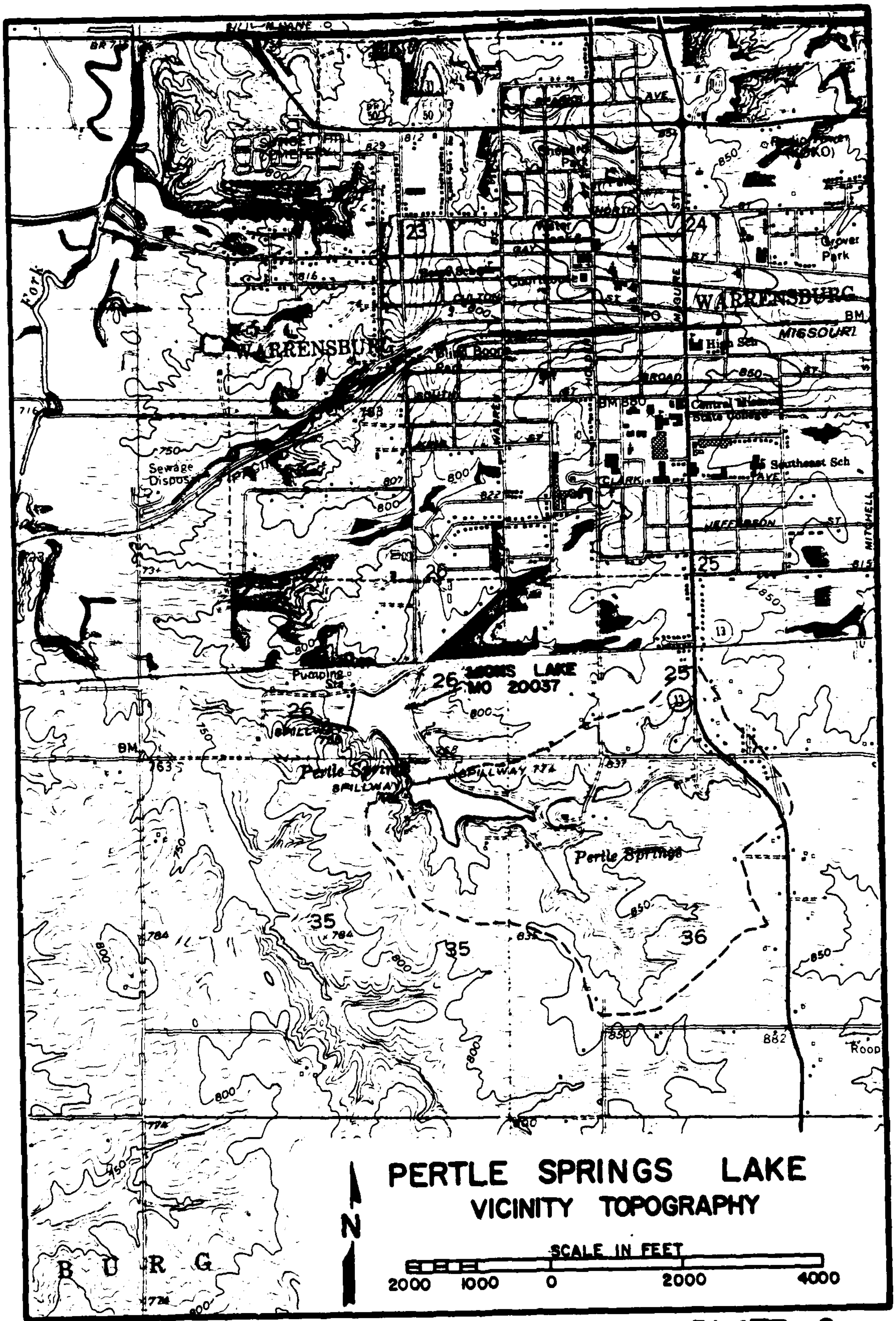
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VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000
N
WARRENSBURG
MISSOURI
Grover Park
High Sch
Central Missouri State College
Southeast Sch
Sewage Disposal
Pumping Sta
Pertle Springs
SPILLWAY
MO 20037
B U R G
23
24
25
26
35
36
850
800
750

PLATE 2

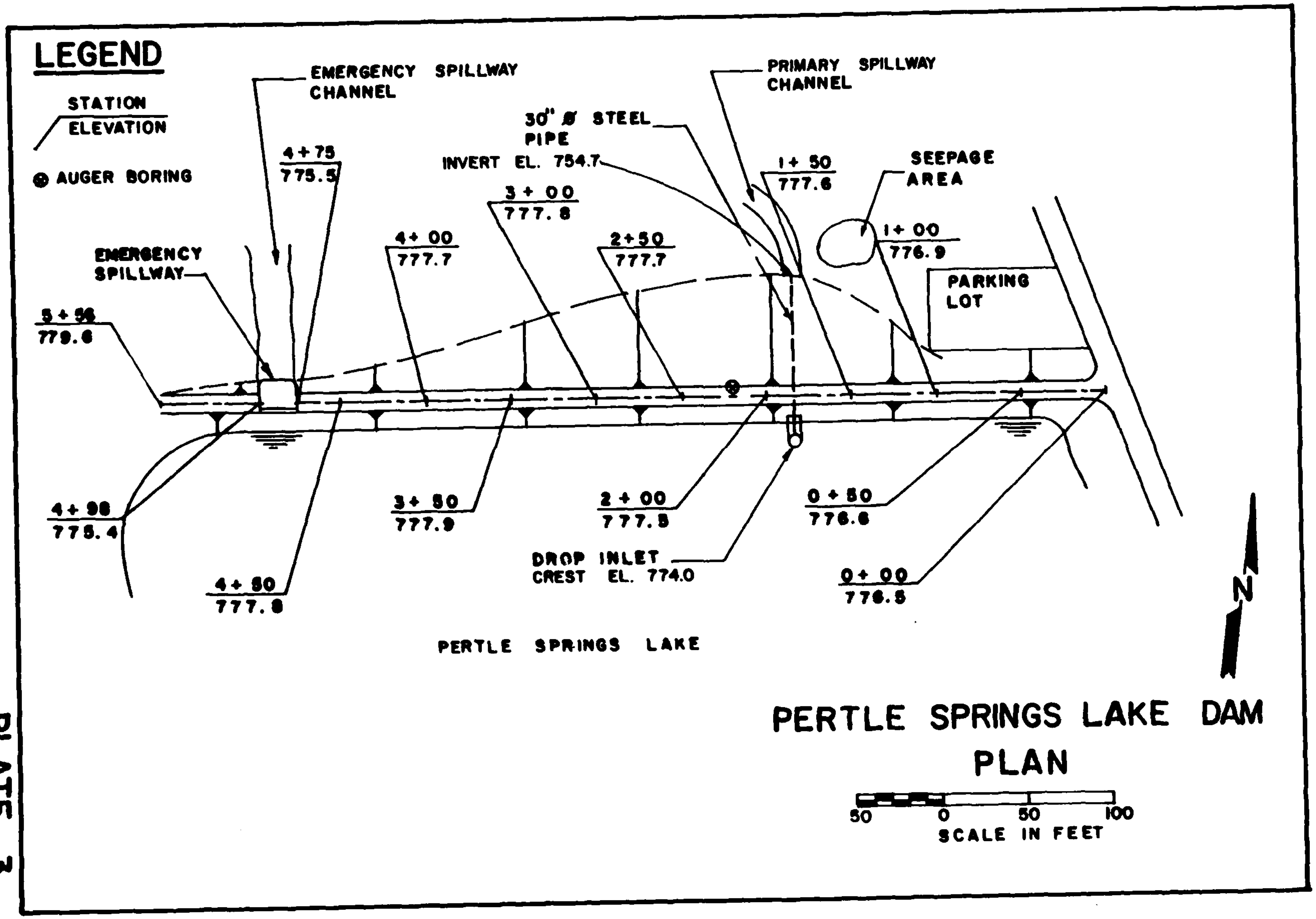
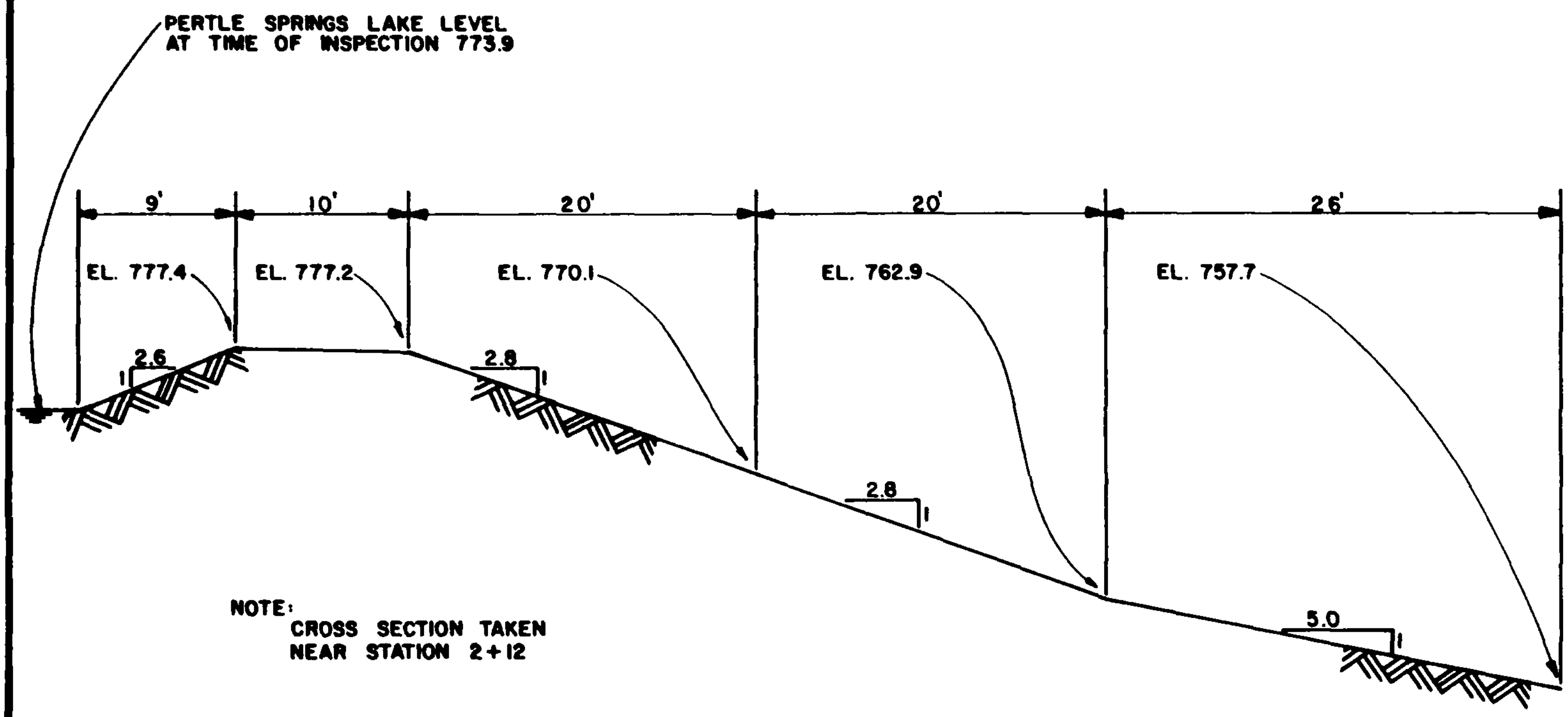

LEGEND
STATION
ELEVATION
⊕ AUGER BORING
EMERGENCY SPILLWAY CHANNEL
EMERGENCY SPILLWAY
30" Ø STEEL PIPE
INVERT EL. 754.7
PRIMARY SPILLWAY CHANNEL
SEEPAGE AREA
PARKING LOT
5 + 56 / 779.6
4 + 75 / 775.5
4 + 98 / 775.4
4 + 80 / 777.8
4 + 00 / 777.7
3 + 50 / 777.9
3 + 00 / 777.8
2 + 50 / 777.7
2 + 00 / 777.5
1 + 50 / 777.6
1 + 00 / 776.9
0 + 50 / 776.6
0 + 00 / 776.5
DROP INLET
CREST EL. 774.0
PERTLE SPRINGS LAKE
N
PERTLE SPRINGS LAKE DAM
PLAN
50
0
50
100
SCALE IN FEET

PLATE 3



PERTLE SPRINGS LAKE DAM
DAM CROSS SECTION

PLATE 4

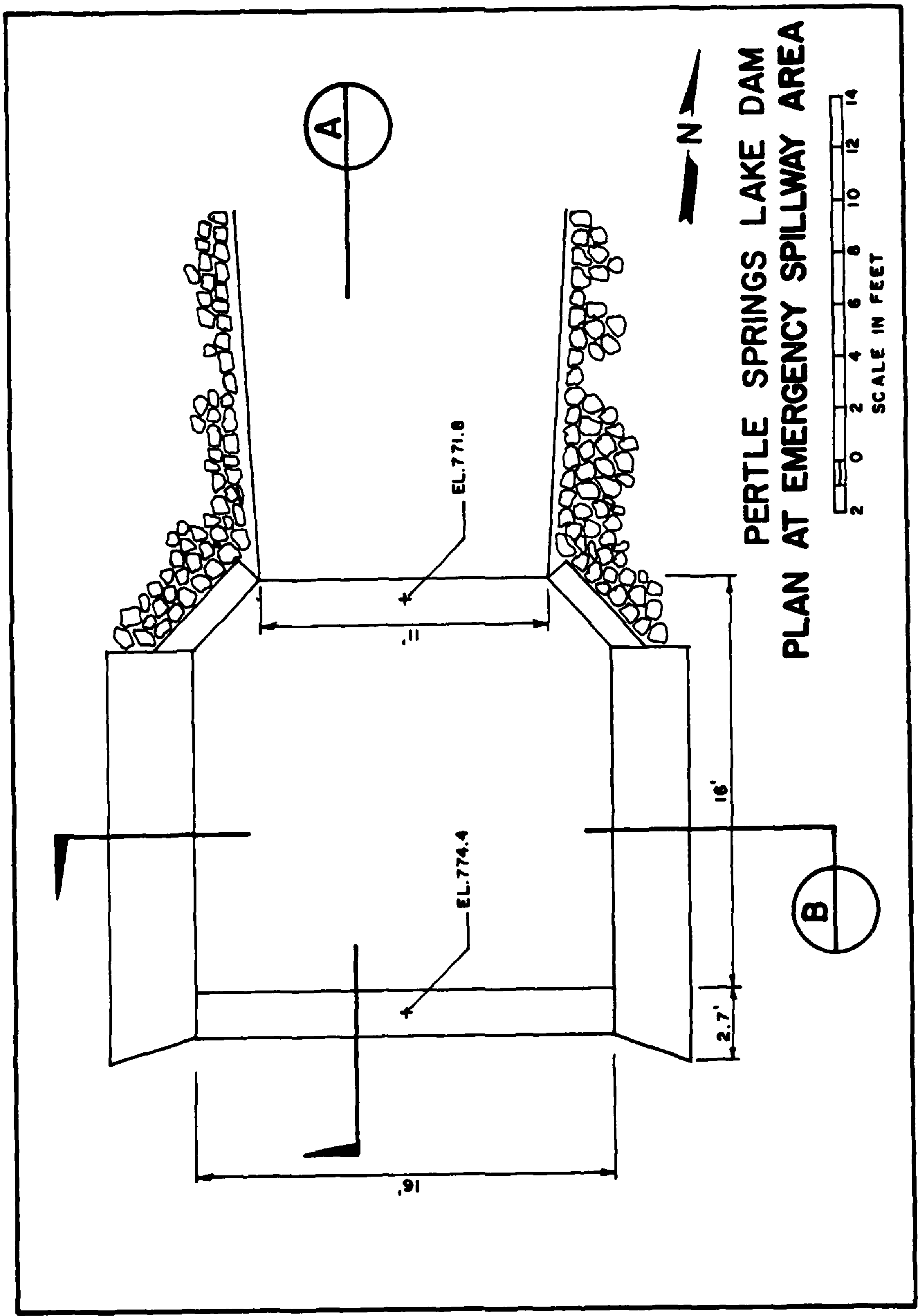

PERTLE SPRINGS LAKE DAM
PLAN AT EMERGENCY SPILLWAY AREA
SCALE IN FEET
2 0 2 4 6 8 10 12 14
N
A
B
EL. 771.8
EL. 774.4
11'
16'
2.7'
16'

PLATE 5

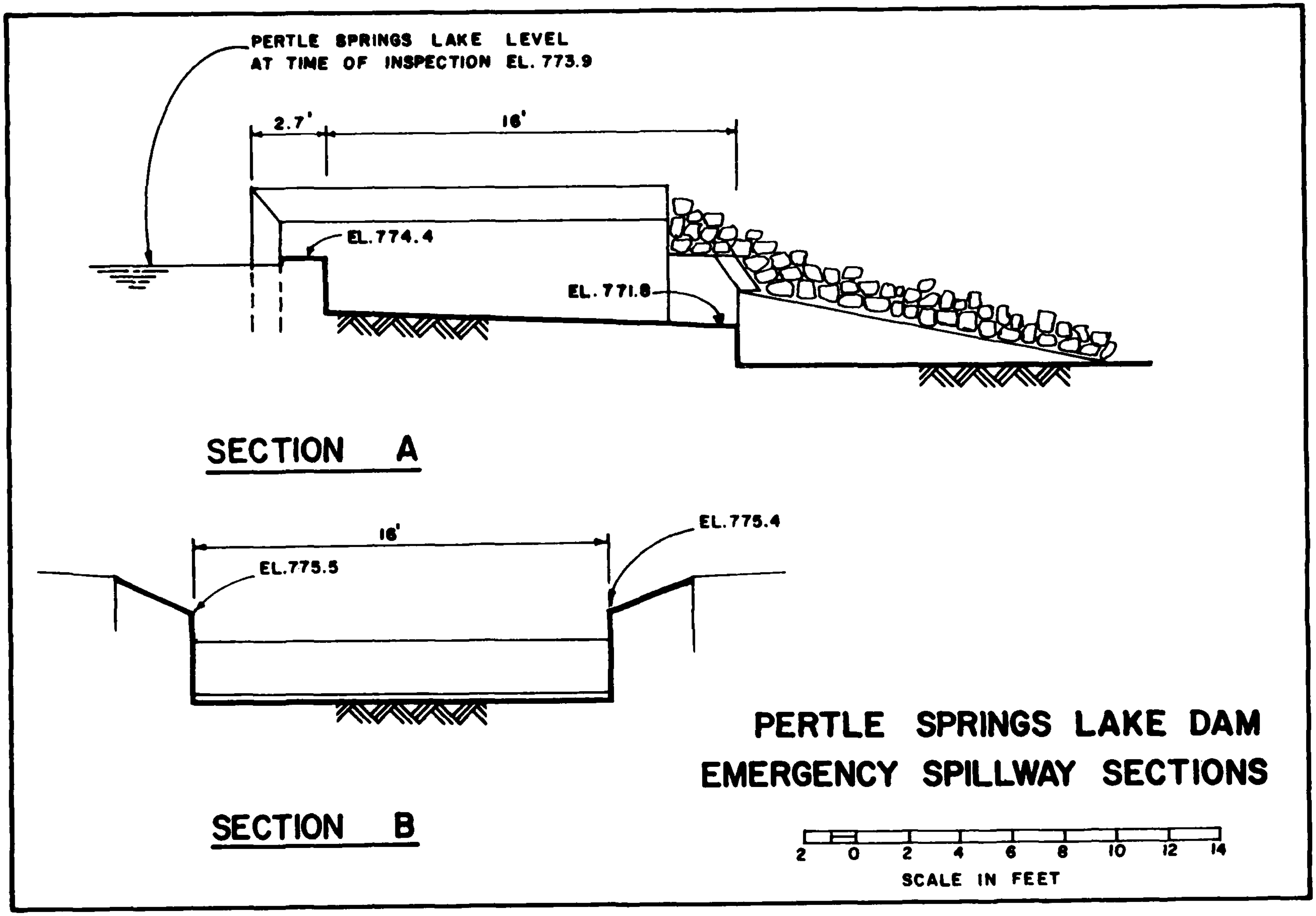

PERTLE SPRINGS LAKE LEVEL
AT TIME OF INSPECTION EL. 773.9
2.7'
16'
EL. 774.4
EL. 771.8
SECTION A
16'
EL. 775.5
EL. 775.4
SECTION B
PERTLE SPRINGS LAKE DAM
EMERGENCY SPILLWAY SECTIONS
2 0 2 4 6 8 10 12 14
SCALE IN FEET

PLATE 6

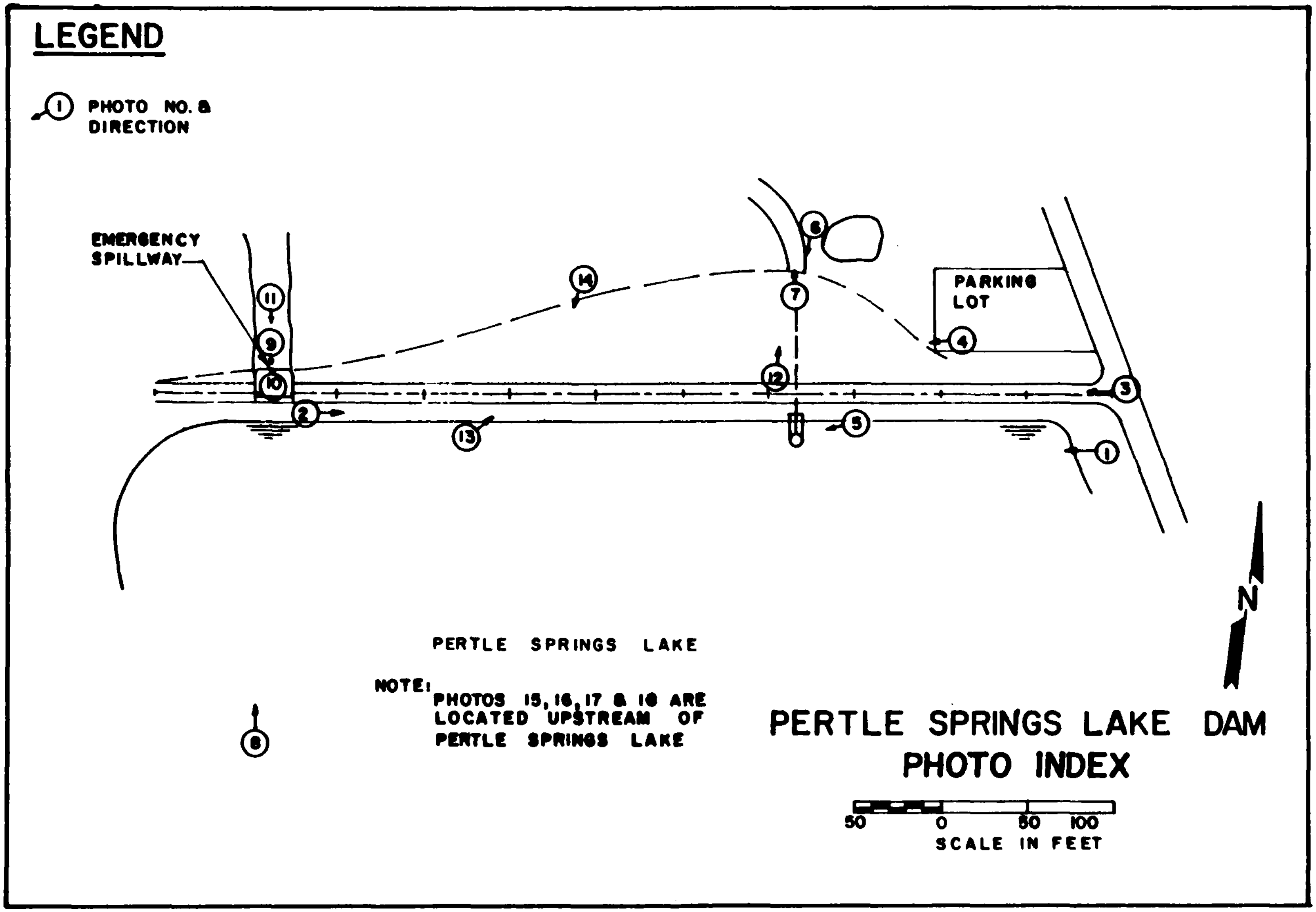

LEGEND
PHOTO NO. & DIRECTION
EMERGENCY SPILLWAY
PARKING LOT
PERTLE SPRINGS LAKE
NOTE: PHOTOS 15, 16, 17 & 18 ARE LOCATED UPSTREAM OF PERTLE SPRINGS LAKE
N
PERTLE SPRINGS LAKE DAM
PHOTO INDEX
50 0 50 100
SCALE IN FEET

PHOTO 1: UPSTREAM FACE OF DAM LOOKING WEST

PHOTO 2: UPSTREAM FACE OF DAM LOOKING EAST

PHOTO 3: CREST OF DAM

PHOTO 4: DOWNSTREAM SLOPE OF DAM

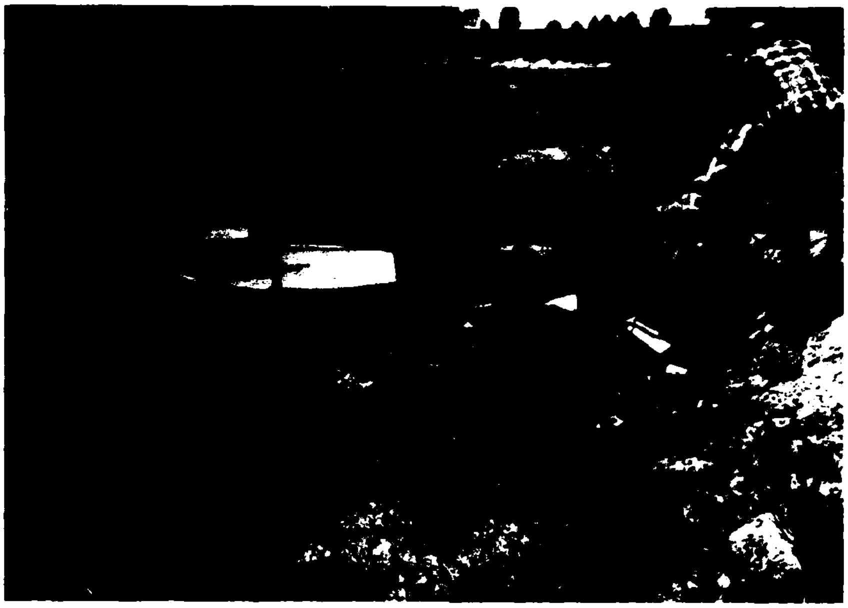


PHOTO 5: PRIMARY SPILLWAY DROP INLET

PHOTO 6: PRIMARY SPILLWAY OUTLET

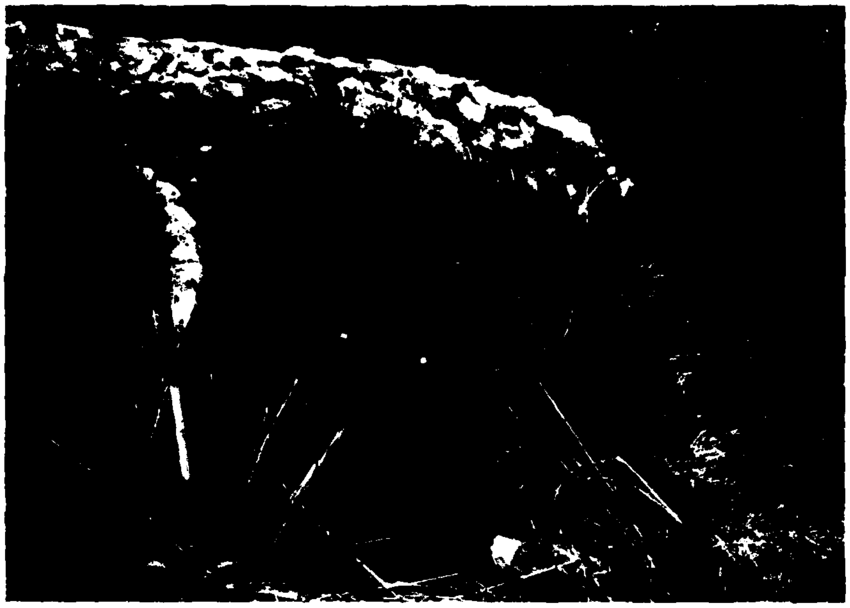


PHOTO 7: CHANNEL BELOW PRIMARY SPILLWAY

PHOTO 8: EMERGENCY SPILLWAY

PHOTO 9: EMERGENCY SPILLWAY CONCRETE SILL LOOKING UPSTREAM

PHOTO 10: CHANNEL BELOW EMERGENCY SPILLWAY SILL

PHOTO 11: SEEPAGE FROM BELOW EMERGENCY SPILLWAY CONCRETE APRON

PHOTO 12: SEEPAGE AREA BELOW DAM AT RIGHT END

PHOTO 13: ANIMAL BURROW IN UPSTREAM FACE OF DAM

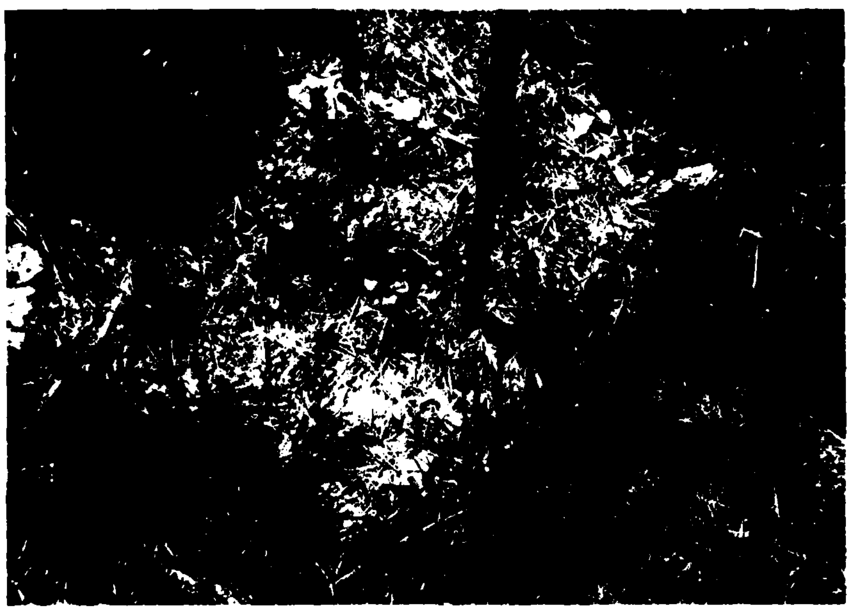


PHOTO 14: ANIMAL BURROW IN DOWNSTREAM SLOPE OF DAM NEAR TOE

PHOTO 15: SMALL POND ABOVE PERTLE SPRINGS LAKE

PHOTO 16: DOWNSTREAM FACE OF DAM FOR UPPER LAKE

PHOTO 17: UPSTREAM FACE OF DAM FOR UPPER LAKE

PHOTO 18: OUTLET PIPE FROM UPPER LAKE

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential of Pertle Sprirgs Lake Dam, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to synthetic unit hydrographs to develop inflow hydrographs for Pertle Springs Lake and its upstream reservoir. The inflow hydrographs were then routed through the reservoirs and spillways. The overtopping analyses were determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33). Reduction factors were not applied. The rainfall distribution for the 48-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411. The Sweet Springs, Missouri rainfall distribution (10 min. interval - 48 hours duration), as provided by the St. Louis District, Corp of Engineers, was used when the one percent chance probability flood was routed through the reservoirs and spillways.

The synthetic unit hydrographs for the watershed were developed by the computer program using the Soil Converation Service (SCS) method. The parameters for the unit hydrographs are shown in Table 1.

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationships. The CN values used, and the result from the computer output, are shown in Table 2.

Although many impoundments exist in the watershed for Pertle Springs Lake, it was determined from visual inspection that only one of the impoundments upstream of Pertle Springs Lake would be included in the hydrologic and hydraulic analyses. Storms were routed through the lake upstream of Pertle Springs Lake (see Plate 2) which shall be referenced as "Upstream Lake" through the remainder of this appendix.

Routing through the reservoirs was performed using the Modified Puls Method. The initial reservoir pool elevations for the routing of each storm were determined to be equivalent to the primary spillway crest elevations in accordance with antecedent storm conditions preceding the one percent probability and probable maximum storms outlined by the U.S. Army Corps of Engineers, St. Louis District (5). The hydraulic capacity of the spillways and the storage capacity of the reservoirs were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curves for the spillways are shown in Table 4. The flow over the crest Pertle Springs Lake dam was determined using the non-level dam crest option ($L and $V cards) of the HEC-1 program. The flow over the upstream dam was determined by HEC-1 assuming a level dam crest.

The program assumes critical flow over a broad-crested weir. The flow through the upstream lake primary spillway was determined by a nomograph for corrugated metal pipe culverts with outlet control. The flow through the Pertle Springs primary spillway was determined from the orifice flow equation. The flow over the Pertle Springs Lake emergency spillway was determined from the weir equation.

Where routings through the upstream reservoir resulted in overtopping of that structure, a breach analysis was performed using HEC-1. The breaching parameters are noted in Table 5.

The result of the routing and breach analysis indicates that 25 percent of the PMF will not overtop the Pertle Springs Lake dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 6.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:	Upstream Lake	Pertle Springs Lake
Drainage Area (A)	179 acres	275 acres
Hydraulic Length of Watercourse (ℓ)	3,900 feet	4,460 feet
Hydrologic Soil Cover Complex Number (CN')	81 (AMC III) 64 (AMC II)	80 63
Average Watershed Land Slope (Y)	2.7%	2.6%
Lag Time (L_g)	0.56 hours (AMC III) 0.90 hours (AMC II)	0.65 hours 0.96 hours
Time of concentration (T_c)	0.93 hours (AMC III) 1.50 hours (AMC II)	1.08 hours 1.73 hours
Duration (D)	7 minutes (AMC III) 12 minutes (AMC II) (use 10 minutes in all cases)	9 minutes 14 minutes

TABLE 1
(Continued)

Time (Min)*	Upstream Lake AMC II	Upstream Lake AMC III	Discharge (cfs)* Pertle Springs Lake AMC II	Discharge (cfs)* Pertle Springs Lake AMC III
0	0	0	0	0
10	11	32	12	35
20	33	106	35	112
30	67	190	71	224
40	108	210	120	280
50	132	182	160	274
60	137	129	182	229
70	129	80	184	162
80	112	53	173	107
90	89	35	154	75
100	64	23	129	52
110	48	15	98	36
120	37	10	75	25
130	28	6	58	17
140	21	4	47	12
150	16	3	37	8
160	12	2	29	6
170	9	1	23	4
180	7	1	18	3

*From HEC-1 computer output

FORMULAS USED:

$$L_g = \frac{\ell^{0.8} \times (S + 1)^{0.7}}{1,900 \times Y^{0.5}} \qquad (4)$$

$$S = \frac{1,000}{CN'} - 10$$

$$T_c = L_g/0.6$$

$$D = 0.133\ T_c$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP				
Upstream Lake	48	34.58	31.92	2.66
Pertle Springs Lake	48	34.58	31.75	2.83
1% Probability				
Upstream Lake	48	8.73	4.37	4.36
Pertle Springs Lake	48	8.73	4.25	4.48

Additional Data:

1) The soil associations in this watershed are Bolivar, Barco, Deepwater, Macksburg, Sampsel, and Weller (3).
   97 percent of total drainage area in hydrologic soil group B.
   3 percent of total drainage area in hydrologic soil group D.
   5 percent of the land use was urban.
   10 percent of the land use was grassland.
   15 percent of the land use was cropland.
   70 percent of the land use was timberland (2 and 4).
2) SCS Runoff Curve CN (AMC III) for ratios of the PMF:
   81 - Upstream Lake
   80 - Pertle Springs Lake
3) SCS Runoff Curve CN (AMC II) for the one percent probability flood:
   64 - Upstream Lake
   63 - Pertle Springs Lake

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
Upstream Lake			
*785.0	1.0	2	0
***789.2	2.7	9	11
Pertle Springs Lake			
*774.0	16.1	75	0
**774.4	17.2	82	14
***777.6	25.8	149	458

*Primary spillway crest elevation
**Emergency spillway crest elevation
***Top of dam elevation

The relationships in Table 3 were developed from the Centerview, Missouri and Cornelia, Missouri 7.5 minute quadrangle maps and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

Reservoir Elevation (ft-msl)	Primary Spillway Discharge (cfs)	Emergency Spillway Discharge (cfs)	Total Spillway Discharges (cfs)
	Upstream Lake		
785.0	0	-	0
786.0	10	-	10
787.0	10	-	10
788.0	10	-	10
789.0	11	-	11
**789.2	11	-	11
790.0	11	-	11
791.0	12	-	12
	Pertle Springs Lake		
774.0	0	-	0
*774.4	14	0	14
775.0	34	19	53
776.0	97	94	191
777.0	142	206	348
**777.6	158	300	458
778.0	169	363	532
779.0	191	524	715

*Emergency Spillway Crest Elevation
**Top of Dam Elevation

METHOD USED:

Upstream Lake

Primary spillway releases were determined by nomographs for corrugated metal pipe culverts with outlet control (7).

Pertle Springs Lake

Primary spillway release rates were based on the discharge calculated for flow through the pipe and drop inlet using the orifice equation:

$$Q = Ca[2gH]^{1/2}$$

where:

C = 0.77 = coefficient of discharge for pipe or
C = 0.57 = coefficient of discharge for drop inlet
a = 7.07 sq. ft. = net area of orifice for pipe or
a = 19.6 sq. ft. = net area of orifice for drop inlet
g = 32.2 ft/sec^2 = gravitational acceleration
H = difference between the energy gradient elevation upstream and the downstream tailwater elevation for pipe or
H = height of water surface above the crest of the drop inlet (6).

Emergency spillway release rates were computed using the weir equation:

$$Q = CLH^{3/2}$$

L = 16 feet
H = head in feet
C = coefficient of discharge and varies between 2.61 and 3.32 (6).

TABLE 5

BREACHING PARAMETERS

	Upstream Lake
Bottom Width of Breach (BRWID)	10 feet
Side Slope of Breach (z) (In feet horizontal to 1.0 feet vertical)	0.5
Elevation of Breach Bottom at Maximum Size of Breach (ELBM)	782.0 ft. m.s.l.
Time for Breach to Develop to Maximum Size (TFAIL)	1.0 hour
Elevation of Water Surface Which Will Cause Dam to Fail (FAILEL)	789.2 ft. m.s.l.

TABLE 6

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	0	*774.0	75	0	-
0.25	1,046	777.6	148	882	0
0.50	2,106	778.3	166	1,994	0.7
1.00	4,325	779.1	189	4,209	1.5

* Primary spillway drop inlet crest elevation.

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(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, Urban Hydrology for Small Watersheds, January, 1975.

(3) U.S. Department of Agriculture, Soil Conservation Service, Preliminary Soils Report for Johnson County, Missouri.

(4) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(5) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 12 December 1979.

(6) Horace W. King and Ernest F. Brater, Handbook of Hydraulics, Sixth Edition, McGraw Hill Book Company, 1976.

(7) U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Engineering Circular No. 5, Hydraulic Charts for the Selection of Highway Culverts, December, 1965.

(8) U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Interpretations and Field Maps, 1980.

(9) Mary H. McCracken, Missouri Division of Geological Survey, Geologic Map of Missouri, 1961.

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
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      1             A1MISSOURI DAM INSPECTION PROGRAM
      2             A2ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
      3             A3LIONS,PERTLE SPRINGS LAKE DAMS
      4             B     286       0      10       0       0       0       0       0       0       0
      5             B1      5
      6             J       1       4       1
      7             J1    .25     .50     .55      1.
      8             K       0       1                               3       1
      9             K1    UPSTREAM DAM (48 HR. PROBABLE MAXIMUM RUNOFF)
     10             M       1       2     .28                       1
     11             P           24.70     101     120     130     140
     12             T                                                      -1     -81
     13             W2                .50
     14             X                       1
     15             K       1       2                                       1
     16             K1    ROUTING THROUGH UPSTREAM DAM
     17             Y                               1       1
     18             Y1      1                                         -785.      -1
     19             Y4   785.    786.    787.    788.    789.    790.    791.
     20             Y5     0.    10.0    10.0    10.0    11.0    11.0    12.0
     21             $A0.0     1.0     3.0    11.1    21.2    44.3
     22             $E785.   785.    790.    800.    810.    820.
     23             $S789.2 0       0       1.5
     24             $D789.2 2.6     1.5     264.
     25             $B10.     .5    782.      1.    785.   789.2
     26             K       0       3                               3       1
     27             K1    PERTLE SPRINGS DAM (48 HR. PROBABLE MAXIMUM RUNOFF)
     28             M       1       2     .43                       1
     29             P           24.70     101     120     130     140
     30             T                                                      -1     -80
     31             W2                .65
     32             X                       1
     33             K       2       4                                       1
     34             K1    COMBINE HYDROGRAPHS-TOTAL FLOW PERTLE SPRINGS (48 HR. PMF)
     35             K       1       5                                       1
     36             K1    ROUTING THROUGH PERTLE SPRINGS LAKE
     37             Y                               1       1
     38             Y1      1                                         -774.      -1
     39             Y4   774.    775.    776.    777.    778.    779.    780.    781.    782.
     40             Y5     0.    53.0    191.    346.    532.    715.    915.   1125.   1341.
     41             $A0.    16.13   32.25   38.32   66.43   77.57    96.8
     42             $E760.   774.    780.    790.    800.    810.    820.
     43             $S774.
     44             $D777.6
     45             $L11.     31.    144.    194.    349.    514.    551.    569.
     46             $V776.  776.5    777.   777.6   777.8    778.    779.   779.5
     47             K      99
```


PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 8
********************************
                        MISSOURI DAM INSPECTION PROGRAM
                        ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
                        LIONS,PERTLE SPRINGS LAKE DAMS

                                         JOB SPECIFICATION
                        NQ     NHR    NMIN    IDAY    IHR    IMIN   METRC    IPLT    IPRT   NSTAN
                       288       3      15       3      0       0       0       0       0       0
                                             JOPER     NWT  LROPT   TRACE
                                                 5       0      0       0

                                  MULTI-PLAN ANALYSES TO BE PERFORMED
                                     NPLAN= 1 NRTIO= 4 LRTIO= 1
                         RTIOS=    .25    .30    .50   1.00

                ***********      ***********      ***********      ***********      ***********

                                     SUB-AREA RUNOFF COMPUTATION

                        UPSTREAM DAM (48 HR. PROBABLE MAXIMUM RUNOFF)

                              ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                  1       0       0       0       0       3       1       0       0

                                         HYDROGRAPH DATA
                        IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                            1      2     .28     .00     .28    1.00    .000       0       0       0

                                            PRECIP DATA
                              SPFE     PMS      R6     R12     R24     R48     R72     R96
                               .00   24.70  101.00  120.00  130.00  140.00     .00     .00

                                             LOSS DATA
                  LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
                      0     .00     .30    1.00     .00     .00    1.00   -1.00  -81.00     .00     .00

                       CURVE NO = -81.00  WETNESS =  -1.00  EFFECT CN =  81.00

                                       UNIT HYDROGRAPH DATA
                                       TC=   .00   LAG=   .56

                                         RECESSION DATA
                              STRTQ=     .00   QRCSN=    .00   RTIOR= 1.00

                     UNIT HYDROGRAPH 19 END OF PERIOD ORDINATES, TC=    .00 HOURS, LAG=   .56  VOL= 1.00
                     32.     106.    193.    210.    182.    129.     82.     53.     35.     23.
                     15.      10.      6.      4.      3.      2.      1.      1.      0.

            0                                 END-OF-PERIOD FLOW
```

MO	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.00	.00	.00	0.	1.02	.10	145	.03	.02	.01	3.
1.01	.20	2	.00	.00	.00	0.	1.02	.20	146	.03	.02	.01	5.
1.01	.30	3	.00	.00	.00	0.	1.02	.30	147	.03	.02	.01	8.
1.01	.40	4	.00	.00	.00	0.	1.02	.40	148	.03	.02	.01	12.
1.01	.50	5	.00	.00	.00	0.	1.02	.50	149	.03	.02	.01	15.
1.01	1.00	6	.00	.00	.00	0.	1.02	1.00	150	.03	.02	.01	17.
1.01	1.10	7	.00	.00	.00	0.	1.02	1.10	151	.03	.02	.01	19.
1.01	1.20	8	.00	.00	.00	0.	1.02	1.20	152	.03	.02	.01	20.
1.01	1.30	9	.00	.00	.00	0.	1.02	1.30	153	.03	.02	.01	20.
1.01	1.40	10	.00	.00	.00	0.	1.02	1.40	154	.03	.02	.01	21.
1.01	1.50	11	.00	.00	.00	0.	1.02	1.50	155	.03	.02	.01	21.
1.01	2.00	12	.00	.00	.00	0.	1.02	2.00	156	.03	.02	.01	22.
1.01	2.10	13	.00	.00	.00	0.	1.02	2.10	157	.03	.02	.01	22.
1.01	2.20	14	.00	.00	.00	0.	1.02	2.20	158	.03	.02	.01	22.
1.01	2.30	15	.00	.00	.00	0.	1.02	2.30	159	.03	.02	.01	22.
1.01	2.40	16	.00	.00	.00	0.	1.02	2.40	160	.03	.02	.01	22.
1.01	2.50	17	.00	.00	.00	0.	1.02	2.50	161	.03	.02	.01	22.
1.01	3.00	18	.00	.00	.00	0.	1.02	3.00	162	.03	.02	.01	22.
1.01	3.10	19	.00	.00	.00	0.	1.02	3.10	163	.03	.02	.01	22.
1.01	3.20	20	.00	.00	.00	0.	1.02	3.20	164	.03	.02	.01	23.
1.01	3.30	21	.00	.00	.00	0.	1.02	3.30	165	.03	.02	.01	23.
1.01	3.40	22	.00	.00	.00	0.	1.02	3.40	166	.03	.02	.01	23.
1.01	3.50	23	.00	.00	.00	0.	1.02	3.50	167	.03	.02	.01	23.
1.01	4.00	24	.00	.00	.00	0.	1.02	4.00	168	.03	.02	.01	23.
1.01	4.10	25	.00	.00	.00	0.	1.02	4.10	169	.03	.02	.01	23.
1.01	4.20	26	.00	.00	.00	0.	1.02	4.20	170	.03	.02	.01	23.
1.01	4.30	27	.00	.00	.00	0.	1.02	4.30	171	.03	.02	.01	23.
1.01	4.40	28	.00	.00	.00	0.	1.02	4.40	172	.03	.02	.01	23.
1.01	4.50	29	.00	.00	.00	0.	1.02	4.50	173	.03	.02	.01	23.
1.01	5.00	30	.00	.00	.00	0.	1.02	5.00	174	.03	.02	.01	23.
1.01	5.10	31	.00	.00	.00	0.	1.02	5.10	175	.03	.02	.01	23.
1.01	5.20	32	.00	.00	.00	0.	1.02	5.20	176	.03	.02	.01	23.
1.01	5.30	33	.00	.00	.00	0.	1.02	5.30	177	.03	.02	.01	24.
1.01	5.40	34	.00	.00	.00	0.	1.02	5.40	178	.03	.02	.01	24.
1.01	5.50	35	.00	.00	.00	0.	1.02	5.50	179	.03	.02	.01	24.
1.01	6.00	36	.00	.00	.00	0.	1.02	6.00	180	.03	.02	.01	24.
1.01	6.10	37	.01	.00	.01	0.	1.02	6.10	181	.13	.11	.02	26.
1.01	6.20	38	.01	.00	.01	0.	1.02	6.20	182	.13	.11	.02	35.
1.01	6.30	39	.01	.00	.01	0.	1.02	6.30	183	.13	.11	.02	52.
1.01	6.40	40	.01	.00	.01	0.	1.02	6.40	184	.13	.11	.02	69.
1.01	6.50	41	.01	.00	.01	0.	1.02	6.50	185	.13	.11	.02	65.
1.01	7.00	42	.01	.00	.01	0.	1.02	7.00	186	.13	.11	.02	97.
1.01	7.10	43	.01	.00	.01	0.	1.02	7.10	187	.13	.11	.02	104.
1.01	7.20	44	.01	.00	.01	0.	1.02	7.20	188	.13	.11	.02	110.
1.01	7.30	45	.01	.00	.01	0.	1.02	7.30	189	.13	.11	.02	114.
1.01	7.40	46	.01	.00	.01	0.	1.02	7.40	190	.13	.11	.02	115.
1.01	7.50	47	.01	.00	.01	0.	1.02	7.50	191	.13	.11	.02	119.
1.01	8.00	48	.01	.00	.01	0.	1.02	8.00	192	.13	.12	.02	120.
1.01	8.10	49	.01	.00	.01	0.	1.02	8.10	193	.13	.12	.01	121.
1.01	8.20	50	.01	.00	.01	0.	1.02	8.20	194	.13	.12	.01	123.
1.01	8.30	51	.01	.00	.01	0.	1.02	8.30	195	.13	.12	.01	123.
1.01	8.40	52	.01	.00	.01	0.	1.02	8.40	196	.13	.12	.01	124.
1.01	8.50	53	.01	.00	.01	0.	1.02	8.50	197	.13	.12	.01	125.
1.01	9.00	54	.01	.00	.01	0.	1.02	9.00	198	.13	.12	.01	126.

1.01	9.10	55	.01	.00	[illegible]	[illegible]

[illegible]	9.10	55	.01	.00	.01	0.	1.02	9.10	199	.13	.12	.01	[illegible]
1.01	9.20	56	.01	.00	.01	0.	1.02	9.20	200	.13	.12	.01	127.
1.01	9.30	57	.01	.00	.01	0.	1.02	9.30	201	.13	.12	.01	127.
1.01	9.40	58	.01	.00	.01	0.	1.02	9.40	202	.13	.12	.01	128.
1.01	9.50	59	.01	.00	.01	0.	1.02	9.50	203	.13	.12	.01	128.
1.01	10.00	60	.01	.00	.01	0.	1.02	10.00	204	.13	.12	.01	129.
1.01	10.10	61	.01	.00	.01	0.	1.02	10.10	205	.13	.12	.01	129.
1.01	10.20	62	.01	.00	.01	0.	1.02	10.20	206	.13	.12	.01	129.
1.01	10.30	63	.01	.00	.01	0.	1.02	10.30	207	.13	.12	.01	130.
1.01	10.40	64	.01	.00	.01	0.	1.02	10.40	208	.13	.12	.01	130.
1.01	10.50	65	.01	.00	.01	0.	1.02	10.50	209	.13	.12	.01	131.
1.01	11.00	66	.01	.00	.01	0.	1.02	11.00	210	.13	.12	.01	131.
1.01	11.10	67	.01	.00	.01	0.	1.02	11.10	211	.13	.12	.01	131.
1.01	11.20	68	.01	.00	.01	0.	1.02	11.20	212	.13	.12	.01	131.
1.01	11.30	69	.01	.00	.01	0.	1.02	11.30	213	.13	.12	.01	132.
1.01	11.40	70	.01	.00	.01	0.	1.02	11.40	214	.13	.12	.01	132.
1.01	11.50	71	.01	.00	.01	0.	1.02	11.50	215	.13	.12	.01	132.
1.01	12.00	72	.01	.00	.01	0.	1.02	12.00	216	.13	.12	.01	133.
1.01	12.10	73	.03	.00	.03	0.	1.02	12.10	217	.42	.39	.02	141.
1.01	12.20	74	.03	.00	.03	0.	1.02	12.20	218	.42	.40	.02	170.
1.01	12.30	75	.03	.00	.03	0.	1.02	12.30	219	.42	.40	.02	222.
1.01	12.40	76	.03	.00	.03	0.	1.02	12.40	220	.42	.40	.02	280.
1.01	12.50	77	.03	.00	.03	1.	1.02	12.50	221	.42	.40	.02	330.
1.01	13.00	78	.03	.00	.03	1.	1.02	13.00	222	.42	.40	.02	366.
1.01	13.10	79	.04	.01	.03	2.	1.02	13.10	223	.50	.48	.02	391.
1.01	13.20	80	.04	.01	.03	3.	1.02	13.20	224	.50	.48	.02	416.
1.01	13.30	81	.04	.01	.03	4.	1.02	13.30	225	.50	.48	.01	442.
1.01	13.40	82	.04	.01	.03	5.	1.02	13.40	226	.50	.49	.01	466.
1.01	13.50	83	.04	.01	.03	6.	1.02	13.50	227	.50	.49	.01	486.
1.01	14.00	84	.04	.01	.03	7.	1.02	14.00	228	.50	.49	.01	500.
1.01	14.10	85	.05	.01	.03	8.	1.02	14.10	229	.62	.61	.01	513.
1.01	14.20	86	.05	.01	.03	9.	1.02	14.20	230	.62	.61	.01	533.
1.01	14.30	87	.05	.02	.03	11.	1.02	14.30	231	.62	.61	.01	561.
1.01	14.40	88	.05	.02	.03	12.	1.02	14.40	232	.62	.61	.01	590.
1.01	14.50	89	.05	.02	.03	14.	1.02	14.50	233	.62	.61	.01	614.
1.01	15.00	90	.05	.02	.03	15.	1.02	15.00	234	.62	.61	.01	632.
1.01	15.10	91	.05	.02	.03	16.	1.02	15.10	235	.57	.56	.01	641.
1.01	15.20	92	.07	.03	.04	18.	1.02	15.20	236	.95	.94	.01	655.
1.01	15.30	93	.13	.06	.07	21.	1.02	15.30	237	1.71	1.69	.02	714.
1.01	15.40	94	.33	.17	.15	31.	1.02	15.40	238	4.27	4.23	.04	939.
1.01	15.50	95	.09	.06	.04	48.	1.02	15.50	239	1.23	1.22	.01	1326.
1.01	16.00	96	.06	.04	.02	65.	1.02	16.00	240	.76	.75	.01	1696.
1.01	16.10	97	.04	.03	.02	71.	1.02	16.10	241	.58	.58	.00	1783.
1.01	16.20	98	.04	.03	.02	67.	1.02	16.20	242	.58	.58	.00	1631.
1.01	16.30	99	.04	.03	.02	57.	1.02	16.30	243	.58	.58	.00	1361.
1.01	16.40	100	.04	.03	.02	48.	1.02	16.40	244	.58	.58	.00	1108.
1.01	16.50	101	.04	.03	.02	42.	1.02	16.50	245	.58	.58	.00	944.
1.01	17.00	102	.04	.03	.02	38.	1.02	17.00	246	.58	.58	.00	835.
1.01	17.10	103	.04	.02	.01	36.	1.02	17.10	247	.46	.45	.00	759.
1.01	17.20	104	.04	.02	.01	34.	1.02	17.20	248	.46	.46	.00	659.
1.01	17.30	105	.04	.02	.01	32.	1.02	17.30	249	.46	.46	.00	645.
1.01	17.40	106	.04	.02	.01	30.	1.02	17.40	250	.46	.46	.00	599.
1.01	17.50	107	.04	.02	.01	28.	1.02	17.50	251	.46	.46	.00	563.
1.01	18.00	108	.04	.02	.01	28.	1.02	18.00	252	.46	.46	.00	539.
1.01	18.10	109	.04	.00	.00	26.	1.02	18.10	253	.04	.04	.00	510.
1.01	18.20	110	.04	.00	.00	24.	1.02	18.20	254	.04	.04	.00	456.

1.01	18.30	111	.00	.00	.00	19.	1.02	18.30	255	.04	.04	.00	[illegible]
1.01	18.40	112	.00	.00	.00	15.	1.02	18.40	256	.04	.04	.00	277.
1.01	18.50	113	.00	.00	.00	10.	1.02	18.50	257	.04	.04	.00	199.
1.01	19.00	114	.00	.00	.00	8.	1.02	19.00	258	.04	.04	.00	144.
1.01	19.10	115	.00	.00	.00	6.	1.02	19.10	259	.04	.04	.00	110.
1.01	19.20	116	.00	.00	.00	5.	1.02	19.20	260	.04	.04	.00	87.
1.01	19.30	117	.00	.00	.00	4.	1.02	19.30	261	.04	.04	.00	72.
1.01	19.40	118	.00	.00	.00	3.	1.02	19.40	262	.04	.04	.00	62.
1.01	19.50	119	.00	.00	.00	3.	1.02	19.50	263	.04	.04	.00	56.
1.01	20.00	120	.00	.00	.00	3.	1.02	20.00	264	.04	.04	.00	52.
1.01	20.10	121	.00	.00	.00	3.	1.02	20.10	265	.04	.04	.00	49.
1.01	20.20	122	.00	.00	.00	3.	1.02	20.20	266	.04	.04	.00	47.
1.01	20.30	123	.00	.00	.00	2.	1.02	20.30	267	.04	.04	.00	46.
1.01	20.40	124	.00	.00	.00	2.	1.02	20.40	268	.04	.04	.00	45.
1.01	20.50	125	.00	.00	.00	2.	1.02	20.50	269	.04	.04	.00	45.
1.01	21.00	126	.00	.00	.00	2.	1.02	21.00	270	.04	.04	.00	44.
1.01	21.10	127	.00	.00	.00	2.	1.02	21.10	271	.04	.04	.00	44.
1.01	21.20	128	.00	.00	.00	2.	1.02	21.20	272	.04	.04	.00	44.
1.01	21.30	129	.00	.00	.00	2.	1.02	21.30	273	.04	.04	.00	44.
1.01	21.40	130	.00	.00	.00	2.	1.02	21.40	274	.04	.04	.00	44.
1.01	21.50	131	.00	.00	.00	2.	1.02	21.50	275	.04	.04	.00	44.
1.01	22.00	132	.00	.00	.00	2.	1.02	22.00	276	.04	.04	.00	44.
1.01	22.10	133	.00	.00	.00	2.	1.02	22.10	277	.04	.04	.00	44.
1.01	22.20	134	.00	.00	.00	2.	1.02	22.20	278	.04	.04	.00	44.
1.01	22.30	135	.00	.00	.00	2.	1.02	22.30	279	.04	.04	.00	44.
1.01	22.40	136	.00	.00	.00	2.	1.02	22.40	280	.04	.04	.00	44.
1.01	22.50	137	.00	.00	.00	2.	1.02	22.50	281	.04	.04	.00	44.
1.01	23.00	138	.00	.00	.00	2.	1.02	23.00	282	.04	.04	.00	44.
1.01	23.10	139	.00	.00	.00	2.	1.02	23.10	283	.04	.04	.00	44.
1.01	23.20	140	.00	.00	.00	2.	1.02	23.20	284	.04	.04	.00	44.
1.01	23.30	141	.00	.00	.00	2.	1.02	23.30	285	.04	.04	.00	44.
1.01	23.40	142	.00	.00	.00	2.	1.02	23.40	286	.04	.04	.00	44.
1.01	23.50	143	.00	.00	.00	2.	1.02	23.50	287	.04	.04	.00	44.
1.02	.00	144	.00	.00	.00	2.	1.03	.00	288	.04	.04	.00	44.
									SUM	34.58	31.92	2.66	34393.
										(878.)(	811.)(	68.)(	973.90)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1783.	719.	232.	119.	34325.
CMS	50.	20.	7.	3.	974.
INCHES		23.89	30.82	31.73	31.73
MM		606.69	782.85	805.99	805.99
AC-FT		357.	460.	474.	474.
THOUS CU M		440.	567.	584.	584.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	446.	180.	59.	30.	8596.
CMS	13.	5.	2.	1.	243.
INCHES		5.97	7.71	7.93	7.93
MM		151.72	195.71	201.50	201.50
AC-FT		89.	115.	118.	118.

THOUS CU M

THOUS CU M	110.	142.	146.	146.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	535.	216.	73.	36.	10315.
CMS	15.	6.	2.	1.	292.
INCHES		7.17	9.25	9.52	9.52
MM		182.07	234.85	241.80	241.80
AC-FT		107.	139.	142.	142.
THOUS CU M		132.	170.	175.	175.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	891.	360.	116.	60.	17192.
CMS	25.	10.	3.	2.	487.
INCHES		11.95	15.41	15.87	15.87
MM		303.45	391.42	402.99	402.99
AC-FT		178.	230.	237.	237.
THOUS CU M		220.	284.	292.	292.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1783.	719.	232.	119.	34385.
CMS	50.	20.	7.	3.	974.
INCHES		23.89	30.82	31.73	31.73
MM		606.89	782.85	805.99	805.99
AC-FT		357.	460.	474.	474.
THOUS CU M		440.	567.	584.	584.

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HYDROGRAPH ROUTING

ROUTING THROUGH UPSTREAM DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
.0	.000	.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-735.	-1

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STAGE       785.00   786.00   787.00   788.00   789.00   790.00   791.00

FLOW           .00    10.00    10.00    10.00    11.00    11.00    12.00

SURFACE AREA=     0.      1.      5.     11.     21.     44.

CAPACITY=     0.      2.     11.     77.    236.    557.

ELEVATION=   780.    785.    790.    800.    810.    820.

                 CREL   SPWID   COQW   EXPW   ELEVL   COQL   CAREA   EXPL
                789.2     .0     .0    1.5     .0      .0     .0      .0

                                  DAM DATA
                         TOPEL    COQD    EXPD   DAMWID
                         789.2    2.6     1.5    264.

                              DAM BREACH DATA
                 BRWID     Z     ELBM    TFAIL    WSEL    FAILEL
                   10.    .50   782.00   1.00   785.00   789.20

                         STATION      2, PLAN 1, RATIO 1

BEGIN DAM FAILURE AT 34.83 HOURS

                     END-OF-PERIOD HYDROGRAPH ORDINATES

                                 OUTFLOW
       0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
       0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
       0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
       0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
       0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
       0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
       0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
       0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
       2.      2.      0.      1.      1.      1.      1.      1.      1.      2.
       2.      2.      3.      3.      4.      5.      6.      7.      8.      9.
       9.      9.      9.      9.      9.      9.      9.      9.      8.      8.
       8.      7.      7.      7.      6.      6.      5.      5.      4.      4.
       4.      3.      3.      3.      2.      2.      2.      2.      2.      2.
       1.      1.      1.      1.      1.      1.      1.      1.      1.      1.
       1.      1.      1.      1.      1.      1.      1.      1.      1.      2.
       2.      2.      3.      3.      3.      3.      4.      4.      4.      4.
       4.      4.      5.      5.      5.      5.      5.      5.      5.      5.
       5.      5.      5.      5.      5.      5.      6.      6.      6.      6.
       6.      6.      6.      7.      9.     10.     10.     10.     10.     10.
      10.     10.     10.     10.     10.     10.     10.     10.     10.     10.
      10.     10.     11.     11.     11.     11.     11.     11.     24.     37.
      61.    126.    190.    210.    173.     64.     30.     39.     49.     62.
      75.     96.     94.    100.    100.    112.    118.    122.    126.    130.
     136.    142.    149.    155.    156.    161.    169.    200.    266.    352.
     413.    423.    388.    329.    273.    232.    205.    186.    171.    159.
     148.    140.    133.    123.    106.     94.     62.     44.     32.     25.
      20.     17.     15.     14.     13.     12.     12.     12.     11.     11.
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OVN

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SUB-AREA RUNOFF COMPUTATION

PERTLE SPRINGS DAM (48 HR. PROBABLE MAXIMUM RUNOFF)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	3	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.43	.00	.43	1.00	.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
.00	24.70	101.00	120.00	130.00	140.00	.00	.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	.00	.00	1.00	.00	.00	1.00	-1.00	-80.00	.00	.00

CURVE NO = -80.00 WETNESS = -1.00 EFFECT CN = 80.00

UNIT HYDROGRAPH DATA
TC= .00 LAG= .65

RECESSION DATA
STRTQ= .00 QRCSN= .00 RTIOR= 1.00

UNIT HYDROGRAPH 21 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= .65 VOL= 1.00

35.	112.	224.	280.	274.	229.	162.	107.	75.	52.
36.	25.	17.	12.	6.	6.	4.	3.	2.	1.
1.									

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.00	.00	.00	0.	1.02	.10	145	.03	.02	.01	4.
1.01	.20	2	.00	.00	.00	0.	1.02	.20	146	.03	.02	.01	6.
1.01	.30	3	.00	.00	.00	0.	1.02	.30	147	.03	.02	.01	10.
1.01	.40	4	.00	.00	.00	0.	1.02	.40	148	.03	.02	.01	15.
1.01	.50	5	.00	.00	.00	0.	1.02	.50	149	.03	.02	.01	19.
1.01	1.00	6	.00	.00	.00	0.	1.02	1.00	150	.03	.02	.01	23.
1.01	1.10	7	.00	.00	.00	0.	1.02	1.10	151	.03	.02	.01	26.
1.01	1.20	8	.00	.00	.00	0.	1.02	1.20	152	.03	.02	.01	28.
1.01	1.30	9	.00	.00	.00	0.	1.02	1.30	153	.03	.02	.01	29.
1.01	1.40	10	.00	.00	.00	0.	1.02	1.40	154	.03	.02	.01	30.
1.01	1.50	11	.00	.00	.00	0.	1.02	1.50	155	.03	.02	.01	31.
1.01	2.00	12	.00	.00	.00	0.	1.02	2.00	156	.03	.02	.01	32.
1.01	2.10	13	.00	.00	.00	0.	1.02	2.10	157	.03	.02	.01	32.
1.01	2.20	14	.00	.00	.00	0.	1.02	2.20	158	.03	.02	.01	32.
1.01	2.30	15	.00	.00	.00	0.	1.02	2.30	159	.03	.02	.01	33.

1.01	2.40	16	.00	.00	.00	0.	1.02	2.40	160	.03	.02	.01	
1.01	2.50	17	.00	.00	.00	0.	1.02	2.50	161	.03	.02	.01	33.
1.01	3.00	18	.00	.00	.00	0.	1.02	3.00	162	.03	.02	.01	33.
1.01	3.10	19	.00	.00	.00	0.	1.02	3.10	163	.03	.02	.01	33.
1.01	3.20	20	.00	.00	.00	0.	1.02	3.20	164	.03	.02	.01	34.
1.01	3.30	21	.00	.00	.00	0.	1.02	3.30	165	.03	.02	.01	34.
1.01	3.40	22	.00	.00	.00	0.	1.02	3.40	166	.03	.02	.01	34.
1.01	3.50	23	.00	.00	.00	0.	1.02	3.50	167	.03	.02	.01	34.
1.01	4.00	24	.00	.00	.00	0.	1.02	4.00	168	.03	.02	.01	34.
1.01	4.10	25	.00	.00	.00	0.	1.02	4.10	169	.03	.02	.01	34.
1.01	4.20	26	.00	.00	.00	0.	1.02	4.20	170	.03	.02	.01	34.
1.01	4.30	27	.00	.00	.00	0.	1.02	4.30	171	.03	.02	.01	35.
1.01	4.40	28	.00	.00	.00	0.	1.02	4.40	172	.03	.02	.01	35.
1.01	4.50	29	.00	.00	.00	0.	1.02	4.50	173	.03	.02	.01	35.
1.01	5.00	30	.00	.00	.00	0.	1.02	5.00	174	.03	.02	.01	35.
1.01	5.10	31	.00	.00	.00	0.	1.02	5.10	175	.03	.02	.01	35.
1.01	5.20	32	.00	.00	.00	0.	1.02	5.20	176	.03	.02	.01	35.
1.01	5.30	33	.00	.00	.00	0.	1.02	5.30	177	.03	.02	.01	35.
1.01	5.40	34	.00	.00	.00	0.	1.02	5.40	178	.03	.02	.01	35.
1.01	5.50	35	.00	.00	.00	0.	1.02	5.50	179	.03	.02	.01	35.
1.01	6.00	36	.00	.00	.00	0.	1.02	6.00	180	.03	.02	.01	36.
1.01	6.10	37	.01	.00	.01	0.	1.02	6.10	181	.13	.10	.03	39.
1.01	6.20	38	.01	.00	.01	0.	1.02	6.20	182	.13	.10	.03	48.
1.01	6.30	39	.01	.00	.01	0.	1.02	6.30	183	.13	.11	.02	67.
1.01	6.40	40	.01	.00	.01	0.	1.02	6.40	184	.13	.11	.02	90.
1.01	6.50	41	.01	.00	.01	0.	1.02	6.50	185	.13	.11	.02	113.
1.01	7.00	42	.01	.00	.01	0.	1.02	7.00	186	.13	.11	.02	133.
1.01	7.10	43	.01	.00	.01	0.	1.02	7.10	187	.13	.11	.02	148.
1.01	7.20	44	.01	.00	.01	0.	1.02	7.20	188	.13	.11	.02	158.
1.01	7.30	45	.01	.00	.01	0.	1.02	7.30	189	.13	.11	.02	165.
1.01	7.40	46	.01	.00	.01	0.	1.02	7.40	190	.13	.11	.02	171.
1.01	7.50	47	.01	.00	.01	0.	1.02	7.50	191	.13	.11	.02	175.
1.01	8.00	48	.01	.00	.01	0.	1.02	8.00	192	.13	.11	.02	179.
1.01	8.10	49	.01	.00	.01	0.	1.02	8.10	193	.13	.11	.02	181.
1.01	8.20	50	.01	.00	.01	0.	1.02	8.20	194	.13	.11	.02	184.
1.01	8.30	51	.01	.00	.01	0.	1.02	8.30	195	.13	.12	.02	185.
1.01	8.40	52	.01	.00	.01	0.	1.02	8.40	196	.13	.12	.01	187.
1.01	8.50	53	.01	.00	.01	0.	1.02	8.50	197	.13	.12	.01	188.
1.01	9.00	54	.01	.00	.01	0.	1.02	9.00	198	.13	.12	.01	190.
1.01	9.10	55	.01	.00	.01	0.	1.02	9.10	199	.13	.12	.01	191.
1.01	9.20	56	.01	.00	.01	0.	1.02	9.20	200	.13	.12	.01	192.
1.01	9.30	57	.01	.00	.01	0.	1.02	9.30	201	.13	.12	.01	193.
1.01	9.40	58	.01	.00	.01	0.	1.02	9.40	202	.13	.12	.01	194.
1.01	9.50	59	.01	.00	.01	0.	1.02	9.50	203	.13	.12	.01	194.
1.01	10.00	60	.01	.00	.01	0.	1.02	10.00	204	.13	.12	.01	195.
1.01	10.10	61	.01	.00	.01	0.	1.02	10.10	205	.13	.12	.01	196.
1.01	10.20	62	.01	.00	.01	0.	1.02	10.20	206	.13	.12	.01	196.
1.01	10.30	63	.01	.00	.01	0.	1.02	10.30	207	.13	.12	.01	197.
1.01	10.40	64	.01	.00	.01	0.	1.02	10.40	208	.13	.12	.01	198.
1.01	10.50	65	.01	.00	.01	0.	1.02	10.50	209	.13	.12	.01	198.
1.01	11.00	66	.01	.00	.01	0.	1.02	11.00	210	.13	.12	.01	199.
1.01	11.10	67	.01	.00	.01	0.	1.02	11.10	211	.13	.12	.01	199.
1.01	11.20	68	.01	.00	.01	0.	1.02	11.20	212	.13	.12	.01	200.
1.01	11.30	69	.01	.00	.01	0.	1.02	11.30	213	.13	.12	.01	200.
1.01	11.40	70	.01	.00	.01	0.	1.02	11.40	214	.13	.12	.01	201.
1.01	11.50	71	.01	.00	.01	0.	1.02	11.50	215	.13	.12	.01	201.

1.01	12.00	72	.01	.00	.01	0.	1.02	12.00	216	.13	.12	.01	[illegible]
1.01	12.10	73	.03	.00	.03	0.	1.02	12.10	217	.42	.39	.02	212.
1.01	12.20	74	.03	.00	.03	0.	1.02	12.20	218	.42	.39	.02	242.
1.01	12.30	75	.03	.00	.03	0.	1.02	12.30	219	.42	.40	.02	363.
1.01	12.40	76	.03	.00	.03	0.	1.02	12.40	220	.42	.40	.02	379.
1.01	12.50	77	.03	.00	.03	0.	1.02	12.50	221	.42	.40	.02	454.
1.01	13.00	78	.03	.00	.03	1.	1.02	13.00	222	.42	.40	.02	518.
1.01	13.10	79	.04	.00	.03	1.	1.02	13.10	223	.50	.48	.02	566.
1.01	13.20	80	.04	.01	.03	2.	1.02	13.20	224	.50	.48	.02	606.
1.01	13.30	81	.04	.01	.03	3.	1.02	13.30	225	.50	.48	.02	646.
1.01	13.40	82	.04	.01	.03	5.	1.02	13.40	226	.50	.48	.02	684.
1.01	13.50	83	.04	.01	.03	6.	1.02	13.50	227	.50	.48	.01	718.
1.01	14.00	84	.04	.01	.03	8.	1.02	14.00	228	.50	.49	.01	745.
1.01	14.10	85	.05	.01	.04	9.	1.02	14.10	229	.62	.61	.02	768.
1.01	14.20	86	.05	.01	.03	11.	1.02	14.20	230	.62	.61	.01	796.
1.01	14.30	87	.05	.01	.03	13.	1.02	14.30	231	.62	.61	.01	833.
1.01	14.40	88	.05	.02	.03	15.	1.02	14.40	232	.62	.61	.01	874.
1.01	14.50	89	.05	.02	.03	17.	1.02	14.50	233	.62	.61	.01	913.
1.01	15.00	90	.05	.02	.03	20.	1.02	15.00	234	.62	.61	.01	946.
1.01	15.10	91	.04	.02	.03	22.	1.02	15.10	235	.57	.56	.01	967.
1.01	15.20	92	.07	.03	.04	24.	1.02	15.20	236	.95	.93	.01	990.
1.01	15.30	93	.13	.06	.07	27.	1.02	15.30	237	1.71	1.68	.02	1057.
1.01	15.40	94	.33	.17	.16	38.	1.02	15.40	238	4.27	4.22	.04	1308.
1.01	15.50	95	.09	.05	.04	57.	1.02	15.50	239	1.23	1.22	.01	1751.
1.01	16.00	96	.06	.03	.02	80.	1.02	16.00	240	.76	.75	.01	2269.
1.01	16.10	97	.04	.03	.02	93.	1.02	16.10	241	.56	.58	.00	2536.
1.01	16.20	98	.04	.03	.02	95.	1.02	16.20	242	.58	.58	.00	2493.
1.01	16.30	99	.04	.03	.02	86.	1.02	16.30	243	.58	.58	.00	2240.
1.01	16.40	100	.04	.03	.02	76.	1.02	16.40	244	.58	.58	.00	1892.
1.01	16.50	101	.04	.03	.02	67.	1.02	16.50	245	.58	.58	.00	1599.
1.01	17.00	102	.04	.03	.02	60.	1.02	17.00	246	.56	.58	.00	1402.
1.01	17.10	103	.04	.02	.01	56.	1.02	17.10	247	.46	.45	.00	1265.
1.01	17.20	104	.04	.02	.01	52.	1.02	17.20	248	.46	.45	.00	1156.
1.01	17.30	105	.04	.02	.01	49.	1.02	17.30	249	.46	.45	.00	1063.
1.01	17.40	106	.04	.02	.01	46.	1.02	17.40	250	.46	.45	.00	982.
1.01	17.50	107	.04	.02	.01	44.	1.02	17.50	251	.46	.45	.00	917.
1.01	18.00	108	.04	.02	.01	42.	1.02	18.00	252	.46	.46	.00	867.
1.01	18.10	109	.00	.00	.00	40.	1.02	18.10	253	.04	.04	.00	818.
1.01	18.20	110	.00	.00	.00	37.	1.02	18.20	254	.04	.04	.00	749.
1.01	18.30	111	.00	.00	.00	32.	1.02	18.30	255	.04	.04	.00	640.
1.01	18.40	112	.00	.00	.00	26.	1.02	18.40	256	.04	.04	.00	513.
1.01	18.50	113	.00	.00	.00	20.	1.02	18.50	257	.04	.04	.00	391.
1.01	19.00	114	.00	.00	.00	15.	1.02	19.00	258	.04	.04	.00	289.
1.01	19.10	115	.00	.00	.00	11.	1.02	19.10	259	.04	.04	.00	237.
1.01	19.20	116	.00	.00	.00	9.	1.02	19.20	260	.04	.04	.00	171.
1.01	19.30	117	.00	.00	.00	7.	1.02	19.30	261	.04	.04	.00	139.
1.01	19.40	118	.00	.00	.00	6.	1.02	19.40	262	.04	.04	.00	117.
1.01	19.50	119	.00	.00	.00	5.	1.02	19.50	263	.04	.04	.00	101.
1.01	20.00	120	.00	.00	.00	5.	1.02	20.00	264	.04	.04	.00	91.
1.01	20.10	121	.00	.00	.00	4.	1.02	20.10	265	.04	.04	.00	83.
1.01	20.20	122	.00	.00	.00	4.	1.02	20.20	266	.04	.04	.00	78.
1.01	20.30	123	.00	.00	.00	4.	1.02	20.30	267	.04	.04	.00	75.
1.01	20.40	124	.00	.00	.00	4.	1.02	20.40	268	.04	.04	.00	73.
1.01	20.50	125	.00	.00	.00	4.	1.02	20.50	269	.04	.04	.00	71.
1.01	21.00	126	.00	.00	.00	4.	1.02	21.00	270	.04	.04	.00	70.
1.01	21.10	127	.00	.00	.00	4.	1.02	21.10	271	.04	.04	.00	69.

[illegible]	[illegible]	[illegible]	0.	.00	.00	4.	[illegible]	[illegible]	272	.04	.04	[illegible]	68.

1.01	21.20	128	.00	.00	.00	4.	1.02	21.20	272	.04	.04	.00	68.
1.01	21.30	129	.00	.00	.00	4.	1.02	21.30	273	.04	.04	.00	68.
1.01	21.40	130	.00	.00	.00	4.	1.02	21.40	274	.04	.04	.00	68.
1.01	21.50	131	.00	.00	.00	4.	1.02	21.50	275	.04	.04	.00	68.
1.01	22.00	132	.00	.00	.00	4.	1.02	22.00	276	.04	.04	.00	68.
1.01	22.10	133	.00	.00	.00	4.	1.02	22.10	277	.04	.04	.00	68.
1.01	22.20	134	.00	.00	.00	4.	1.02	22.20	278	.04	.04	.00	68.
1.01	22.30	135	.00	.00	.00	4.	1.02	22.30	279	.04	.04	.00	68.
1.01	22.40	136	.00	.00	.00	4.	1.02	22.40	269	.04	.04	.00	68.
1.01	22.50	137	.00	.00	.00	4.	1.02	22.50	261	.04	.04	.00	68.
1.01	23.00	138	.00	.00	.00	4.	1.02	23.00	262	.04	.04	.00	68.
1.01	23.10	139	.00	.00	.00	4.	1.02	23.10	263	.04	.04	.00	68.
1.01	23.20	140	.00	.00	.00	4.	1.02	23.20	264	.04	.04	.00	68.
1.01	23.30	141	.00	.00	.00	4.	1.02	23.30	265	.04	.04	.00	68.
1.01	23.40	142	.00	.00	.00	4.	1.02	23.40	266	.04	.04	.00	68.
1.01	23.50	143	.00	.00	.00	4.	1.02	23.50	267	.04	.04	.00	68.
1.02	.00	144	.00	.00	.00	4.	1.03	.00	268	.04	.04	.00	68.

SUM 34.58 31.75 2.83 52522.
(878.)(806.)(72.)(1487.26)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2536.	1097.	355.	182.	52483.
CMS	72.	31.	10.	5.	1486.
INCHES		23.74	30.69	31.54	31.54
MM		603.03	779.31	801.07	801.07
AC-FT		544.	703.	723.	723.
THOUS CU M		671.	867.	892.	892.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	634.	274.	89.	46.	13121.
CMS	18.	8.	3.	1.	372.
INCHES		5.94	7.67	7.88	7.88
MM		150.76	194.83	200.27	200.27
AC-FT		136.	176.	181.	181.
THOUS CU M		168.	217.	223.	223.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	761.	329.	106.	55.	15745.
CMS	22.	9.	3.	2.	446.
INCHES		7.12	9.20	9.46	9.46
MM		180.91	233.79	240.32	240.32
AC-FT		163.	211.	217.	217.
THOUS CU M		201.	260.	268.	268.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 3

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	2.	3.
4.	6.	8.	10.	12.	14.	17.	20.	23.	26.
29.	[illegible]	37.	45.	67.	[illegible]	103.	105.	98.	97.
77.	71.	67.	43.	60.	[illegible]	75.	102.	144.	221.
238.	185.	60.	25.	16.	14.	12.	10.	9.	8.
7.	7.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	7.	10.	16.	24.	32.	39.
44.	47.	49.	51.	52.	53.	54.	54.	55.	55.
55.	56.	56.	56.	56.	57.	57.	57.	57.	57.
58.	58.	58.	58.	58.	59.	59.	59.	59.	59.
63.	75.	107.	150.	187.	223.	247.	264.	276.	295.
292.	297.	302.	305.	308.	311.	313.	315.	317.	318.
320.	321.	322.	323.	325.	326.	327.	328.	329.	329.
330.	331.	332.	333.	333.	334.	346.	395.	491.	620.
747.	852.	933.	1000.	1065.	1128.	1185.	1230.	1269.	1312.
1373.	1438.	1503.	1556.	1596.	1632.	1728.	2082.	2987.	3901.
4325.	4162.	3659.	3050.	2577.	2267.	2052.	1902.	1760.	1629.
1519.	1435.	1356.	1248.	1070.	867.	655.	477.	355.	275.
221.	185.	161.	145.	134.	127.	122.	119.	116.	115.
113.	113.	113.	113.	113.	113.	113.	113.	113.	113.
113.	113.	113.	113.	113.	113.	113.	113.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4325.	1815.	566.	302.	66951.
CMS	122.	51.	17.	9.	2462.
INCHES		23.78	30.73	31.65	31.65
MM		604.12	780.45	803.78	803.78
AC-FT		900.	1163.	1198.	1198.
THOUS CU M		1110.	1434.	1477.	1477.

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HYDROGRAPH ROUTING

ROUTING THROUGH PERTLE SPRINGS LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
.0	.000	.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-774.	-1

STAGE	774.00	775.00	776.00	777.00	778.00	779.00	780.00	781.00	782.00
FLOW	.00	53.00	191.00	348.00	532.00	715.00	915.00	1125.00	1341.00
SURFACE AREA=	0.	16.	32.	38.	66.	78.	97.		

CAPACITY=	0.	75.	218.	570.	1097.	1807.	2677.
ELEVATION=	762.	774.	780.	790.	800.	810.	820.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
774.0	.0	.0	.0	.0	.0	.0	.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
777.6	.0	.0	0.

CREST LENGTH AT OR BELOW	11.	31.	144.	194.	347.	514.	551.	569.
ELEVATION	776.0	776.5	777.0	777.6	777.8	778.0	779.0	779.5

STATION 5, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	2.	2.	2.	3.	4.	5.	6.	7.	8.
9.	9.	10.	11.	11.	11.	12.	12.	12.	13.
13.	13.	13.	13.	13.	12.	12.	12.	12.	12.
11.	11.	11.	10.	10.	10.	10.	9.	9.	9.
8.	8.	8.	8.	7.	7.	7.	7.	7.	6.
6.	6.	6.	6.	5.	5.	5.	5.	5.	5.
5.	6.	6.	6.	6.	6.	7.	7.	7.	7.
7.	8.	8.	8.	8.	8.	9.	9.	9.	9.
9.	10.	10.	10.	10.	10.	11.	11.	11.	11.
11.	11.	12.	12.	13.	14.	16.	17.	19.	20.
21.	23.	24.	25.	27.	28.	29.	30.	31.	32.
33.	35.	36.	36.	37.	38.	39.	40.	41.	43.
45.	49.	56.	77.	93.	101.	101.	100.	101.	105.
111.	120.	129.	140.	151.	162.	173.	185.	197.	216.
224.	237.	255.	271.	286.	304.	322.	349.	402.	508.
665.	607.	682.	879.	825.	748.	676.	614.	561.	517.
480.	450.	425.	402.	378.	351.	323.	295.	269.	245.
224.	204.	188.	175.	163.	151.	140.	130.	121.	112.
105.	97.	91.	85.	80.	75.	70.	66.	62.	59.
56.	53.	52.	51.	50.	49.	49.	48.		

STORAGE

75.	75.	75.	75.	75.	75.	75.	75.	75.	75.
75.	75.	75.	75.	75.	75.	75.	75.	75.	75.
75.	75.	75.	75.	75.	75.	75.	75.	75.	75.
75.	75.	75.	75.	75.	75.	75.	75.	75.	75.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .25	RATIO 2 .30	RATIO 3 .50	RATIO 4 1.00
				RATIOS APPLIED TO FLOWS			
HYDROGRAPH AT	1	.28	1	446.	535.	891.	1783.
	(	.73)	(	12.62)(	15.14)(	25.24)(	50.48)(
ROUTED TO	2	.28	1	423.	506.	859.	1789.
	(	.73)	(	11.97)(	14.34)(	24.33)(	50.67)(
HYDROGRAPH AT	3	.43	1	634.	761.	1268.	2536.
	(	1.11)	(	17.95)(	21.54)(	35.90)(	71.80)(
2 COMBINED	4	.71	1	1046.	1254.	2106.	4325.
	(	1.84)	(	29.63)(	35.52)(	59.63)(	122.46)(
ROUTED TO	5	.71	1	882.	1111.	1994.	4209.
	(	1.84)	(	24.98)(	31.46)(	56.46)(	119.17)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	[illegible]	769.20	769.20
STORAGE	2.	9.	9.
OUTFLOW	0.	11.	11.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	769.29	.09	9.	423.	.50	40.33	34.83
.30	769.29	.09	9.	506.	.52	40.33	33.83
.50	769.38	.18	9.	859.	.92	40.33	32.33
1.00	790.31	1.11	12.	1789.	1.98	40.17	17.67

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	774.00	774.00	777.60
	STORAGE	75.	75.	149.
	OUTFLOW	0.	0.	924.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	777.50	.00	148.	682.	.00	40.50	.00
.30	777.77	.17	153.	1111.	.67	40.50	.00
.50	778.27	.67	166.	1994.	4.00	40.33	.00
1.00	779.05	1.45	189.	4209.	5.33	40.33	.00

END
DATE
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